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HOW TO KEEP THE CLOCK RIGHT

T. WARNER

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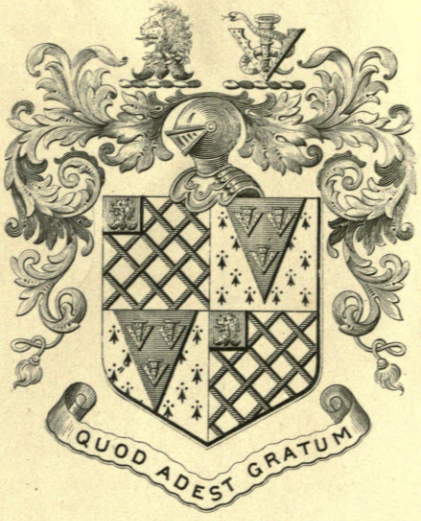
C. K. OGDEN



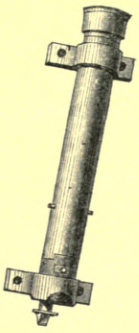
Edward Chaddock Lowndes.
CASTLE COMBE.

Vol 5 Star passes wire about 10m 31s late
Diameter of field of Transit = 2° 05'

HOW TO KEEP THE CLOCK RIGHT

BY OBSERVATIONS OF THE FIXED STARS

WITH A SMALL FIXED TELESCOPE.



TOGETHER WITH

TABLES OF STARS

ARRANGED TO SHOW, BY THE USE OF

A LITTLE ARITHMETIC,

THE MEAN SOLAR TIME OF THEIR APPARENT TRANSITS, TO THE END OF THE CENTURY.

BY THOMAS WARNER.

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HOW TO KEEP THE CLOCK RIGHT.

THE DIFFERENT METHODS usually adopted for keeping time with tolerable accuracy, by means of observations of the heavenly bodies, may, with some convenience, be divided into two great classes:—

First, observations of the *altitudes* of the objects observed. The advantages of this method are, that the instruments, sextants, &c., are portable, and can be used when other instruments would be unavailable, as on board ship: amongst the disadvantages may be mentioned the trouble of reducing the observations.

The second class consists of observations on the *meridian*. This class must, however, be subdivided into two divisions; the first, when the observations are made with good transit instruments, which are occasionally examined for errors, and of which the errors are known and allowed for. The observations by such instruments are the most perfect of any—but the instruments are costly; they require and deserve careful treatment, and trouble and skill are necessary in detecting the errors.

The second subdivision comprises observations made with inferior transit instruments, or good ones which are not occasionally examined for errors. Fixed meridian lines, across which a bright spot of sunlight, from a small hole in the roof above, passes at apparent noon, and dipleidoscopes. The advantages of these instruments are that if they have been once fixed nearly in the meridian (no very difficult matter in the case of the transit), they will continue to give fairly approximate time as long as they keep their position.

The disadvantages of these instruments are, that some of them (transits), are rather costly, and require considerable care; and the others, meridian lines, and dipleidoscopes are with difficulty fixed in the meridian, and when not fixed in the meridian, will give instrumental errors, differing with the different declinations of the objects observed, and all are liable

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to give erroneous results through the shifting or bending of what they are fixed to.

This is the chief defect of the fixed telescope for observing the stars, which, night after night, and year after year, pass across its field.

But when we consider that with an exposed pillar or building, if the sky has been clear during the morning, the sun has had all that time to bend the pillar, &c., to the west; and that the observation (if of the sun), will be taken when the bending is nearly at its maximum; and that if the morning has been dull, and the sun has come out only a short time before noon, the pillar, when the observation is taken, will be but little bent; it must be clear that meridian solar observations with exposed pillars, and fixed and untested instruments, are likely to give discordant results, and can hardly be sufficiently depended upon.

The case is different when fixed telescopes are used for observing the stars; when these are used, even if the pillar has been exposed to the sun and has been bent during the day-time, the interval which would generally elapse before the stars became visible would allow the pillar to resume much of its proper form; but for observations in the zone, 50 to 53 N. P. D., it would often be easy to build the pillar so that it should never be exposed to the action of the sun, and consequently one important source of instrumental error would be much diminished if not obviated altogether.

If, however, the ground upon which the pillar is built should be subject to much movement the case is more difficult; sextants or examined transits could alone give fairly good results, and the examination of the transit must be unpleasantly frequent.

In the Isle of Wight there is a considerable district where a fixed instrument would be useless; on the other hand, the pillars of the Greenwich transit are known to have a very slow alternating movement, extending over many months, and affecting the time of the transit of a zenith star by less than a second.

I am at present unable to describe the best form of telescope for fixing to a pillar; I have tried a few experiments, but in consequence of not being perfectly satisfied with my designs, shall describe one, which, though not actually existing, may be considered a combination of what I have already tried and found to succeed, may be safely relied upon, and is unquestionably very simple.

The telescope is similar to that of a 14-inch dumpy level (of Messrs. Troughton & Simms' construction, who have made the telescopes I have experimented with); the object glass corrected for parallel rays is a cemented one of $1\frac{1}{2}$ inch aperture; the eyepiece end is of the usual form, and has a prism attached to the eyepiece for facilitating observations near the zenith; the diaphragm plate, which is able to turn in the axis of the telescope through an angle of 10 to 20 degrees, has in the centre of the field a pair of parallel wires, each thick enough to obscure a star for about two seconds, and the distance between the wires is such that a star would take from 8 to 10 seconds in passing from the first wire to the second. There are two other wires, each thick enough to obscure a star for 8 seconds, one on each side of the pair and parallel to it, and perhaps a sixteenth of an inch from it; these latter are of use when stars are occasionally rendered invisible by passing clouds.

The reason for having a pair of parallel wires in the centre, instead of a single one, is that an observation would, with this construction, be made by looking for the reappearance of the star from behind the first wire, taking the time of the reappearance from the watch, then seeing the star disappear behind the second wire and taking the time of the disappearance, and adopting the mean as the time of the instrumental transit. The eye has no difficulty in keeping itself fixed for two seconds while waiting for the reappearance of the star from behind the first wire, nor in finding the star between the two wires after it has been withdrawn to look at the watch.

The case is not so with the single wire; the star is invisible when the watch is first looked at, and the eye has to be directed on returning to the telescope, not to the star, but to that part of the wire where the star is to reappear; and when the star is small, it is frequently not caught at the right instant.

The telescope should be fastened to the pillar by screw bolts and brackets fixed as near as may be to the two ends of the telescope.

The above is the *simplest* form of telescope that I can recommend.

With a telescope optically similar and with a field of more than 1° in declination, I have observed with ease Vega in mid-day and 7th magnitude stars at night.

The telescope should be thus fixed: 1st, the optician should mark on the inner tube the distance it should be drawn out, so

that the image of the star and the wires should be the same distance from the object glass. 2nd, the telescope should be fixed against the pillar so as to show the zone of stars intended to be observed. 3rd, the wires should be placed at right angles to the path of the stars. This must be done by comparing the *observed* interval between the passage of a star at the north end of the field and of one at the south end, with the interval given in some good star catalogue, or such tables as the following, which are more convenient, and having ascertained the difference of the intervals and having calculated the proper correction turning the diaphragm round the requisite amount. Example: suppose the *observed* interval between the transit across the wires of (in hour 2) 1 Gr. 250 and 3 Gr. 199 be 6 m. 14 s. and the interval shown by the tables be 6 m. 22·75 sec., the difference between the intervals will be 8·75 sec, which will have been caused by the wires not being at right angles to the path of the stars. Now the difference in the NP Distances of the stars is 48′ and the space passed over by the stars in this list in one second of time is about equal to 12″ or one-fifth of a minute of arc; consequently, the wires diverge from the line at right angles to the path of the stars by an inclination of $8{\cdot}75 \div (48 \times 5)$, and consequently the southern end of the diaphragm must be turned to the west by that amount.

When the wires have been placed nearly at right angles to the path of the stars it would be better not to alter the position till the error had been estimated by the average of several double observations, shown to have been sufficiently well taken by their tolerable agreement with each other.

It is well to remember that errors may be so small that it would be better to allow for them than to attempt to correct them.

Having adjusted the wires at right angles to the path of the stars or parallel to a meridian, the fourth and last step is to ascertain the error of the instrument; that must be done by comparing the time, according to a watch or chronometer the error of which is known, at which a star is observed to pass the wires, with the time the star should cross the meridian according to the tables; thus, supposing on some night a star is observed to pass the wires at 8 h. 10 m. 20 sec., and according to the tables it should pass the meridian at 8 h. 9 m. 10 sec., the error of the instrument will be + 1 m. 10 sec., and this will be the same for all stars and for all time till the telescope from any cause becomes moved.

This instrumental error, when combined with the mean solar time of the apparent transit, on any day, of any of the stars in the following list, which may be easily found from the tables, will give the mean solar time of the star's *passing the telescope*; and from that the error of the clock or chronometer may be discovered and corrected.

The 14-inch telescope I have described, though scarcely admitting of any greater simplicity, may be improved by using a sliding eyepiece so as to increase the range of declination. I have one, shown in the vignette in the title page, which gives more than 3 degrees of declination; the stars certainly have tails at the extremity of the field, but that is not of much consequence since the stars disappear instantaneously enough. A more serious objection is, however, the want of a slow motion for adjusting the wires at right angles to the path of the stars, an error in their position amounting to an inclination of 1 in 900, making a difference of 1 second in the passage of an extreme northern and an extreme southern star. I have in trial a 2-inch glass, 30-inch focus, with more than 3° range in declination, and have found it answer optically very well indeed; it would show the companion to the pole star nearly to the extreme end of the field. The tube is sloped off near the eye-piece, so as to enable the eye to reach the prism with greater ease; it has also a slow motion for fixing the wires at right angles to the path of the stars, and I find the adjustment easy up to my powers of observing; eighth-magnitude stars are quite large enough for it (very many, however, of these small stars have not been accurately catalogued, and are consequently of little use for keeping time by). The telescope is now attached to a pillar by two cast-iron cradles—one at each end. A single cradle would have been better, and then perhaps the instrument might have been worthy of a fuller description.

An objection may be reasonably urged against the use of such telescopes—that it is impossible to depend upon the perfect rigidity of the pillars or upon the stability of the ground they stand upon; no doubt it is so. At the same time, there is reason to think that generally the movements are very small, and the most important of them, that of level, can be to a certain extent detected and allowed for.

The tubular part of a spirit level, sufficiently sensitive to indicate a change of one minute of arc by the movement of the bubble over an inch in the length of the tube, might be

attached by means of a horizontal iron bar and vertical adjusting screws to the pillar at about the height of the middle of the telescope; and then in these latitudes and with the stars in the tables, the movement of one inch in the bubble would represent an alteration in time of five seconds.

The level would not of course show any change in azimuth, but in these latitudes, and with stars so near the zenith as those in the list, the change in time produced by azimuthal movement is very much less than that produced by an equal change in level; and it is not probable that in a detached pillar there would be any azimuthal change, unaccompanied by a much greater change in level—a change which would be detected by the spirit level, and would indicate that the pillar, or the ground it stood upon, was unsuitable for a fixed instrument of any sort, at least without frequent testing.

Perhaps the best arrangement for the instrument would be a cast-iron cradle to carry a 2-inch telescope, 24 to 30 inch focus, with a sliding eye-piece, and also to carry the spirit level, the cradle, &c., to be fastened to corbels projecting from the north side of the pillar. The instrument to be protected from the weather by a box hung as a door to the pillar. The pillar should have a thoroughly good foundation, and should certainly not be less than eighteen inches square—the bricks and corbels should be set in Portland cement.

Such is the Fixed Telescope, at present admitting of many improvements, but very simple; it has no working parts affecting the accuracy of the observations taken with it, and is not likely to be disarranged by unskilful usage. *It will not find the time*, but the time having been once found I believe it will *keep* it in a very satisfactory manner, and though it may take something from Astronomy and give little in return, it is calculated to be of no small service to Horology. The tables of stars to be observed with it, have been carefully prepared from the highest authorities, and have been arranged so as to be readily used by those who are not astronomers, and whose acquaintance with mathematics is limited to the knowledge of a little arithmetic. With these facilities for reducing the observations of the fixed stars to mean solar time, is it too much to hope that others may improve upon the instrument?

47 Sussex Square, Brighton.

CORRECTION.

Since these Tables were printed a small error in them has been pointed out to me, which, though of no practical importance, requires notice.

The formula $\alpha + A\alpha + B\delta$ &c. p. [61], which has been used in the construction of Tables II. III. and the L.N.E. of Table V., contains the quantities $C''m$ and $-\cdot02519$ sin 2 $\odot$ m. These quantities refer the right ascensions of the stars to the *true* equinox instead of to the *mean* equinox, which Table IV. relates to.

This introduces an error, affecting all the stars alike, which might gradually increase from nothing to 2·3 seconds in the space of 9·3 years, after which it would gradually diminish, till, at the end of a like period, the error would vanish, and would begin again a similar fluctuation. Auxiliary Tables of $-C''m$ and $+\cdot02519$ sin 2 $\odot$ m would of course enable this error to be corrected, and they are here subjoined, Tables IIa. and IIIa. They ought, when combined with Tables I. II. III. and IV., to bring the mean times of the transits of the stars to a close agreement with that derived from the Nautical Almanac.—See the examples which follow.

An inspection, however, of the two Auxiliary Tables will show that, while the Table IIIa contains only quantities so small that they may be here safely neglected altogether in practice, the values in Table IIa change so slowly that they might, if it were worth while to take any notice of them, be conveniently combined with the instrumental correction, which might be changed accordingly every year or two.

But, perhaps, the best way to deal with this variation would be to take notice of it only when fixing the instrumental error, p. 6, and afterwards when comparing the time given by the fixed telescope and Tables with that derived from other accurate sources.

Thus, suppose that on Jan. 1, 1870, a star is observed to pass the telescope at 5h. 17m. 28s. P.M., and that according to the original tables it should pass the meridian at 5h. 16m. 16·73s. then correcting this latter time by the Auxiliary Table IIa, 1870+0·93, IIIa Jan. 1,—0·03, the exact time of the star's passing the meridian will be 5h. 16m. 17·63s., and the mean instrumental correction will be 5h. 17m. 28s.—5h. 16m. 17·63s., or 1m. 10·37s., which may be used on all occasions, excepting when comparing the time by the fixed telescope, and that derived from other accurate sources, on which occasions the Auxiliary Tables should be referred to.

AUXILIARY CORRECTIONS.

TABLE IIa.

	Jan. 1 sec.	July 3 sec.
1868	+ 0·40	+ 0·56
1869	+ 0·71	+ 0·83
1870	+ 0·93	+ 1·00
1871	+ 1·04	+ 1·05
1872	+ 1·03	+ 0·99
1873	+ 0·91	+ 0·81
1874	+ 0·69	+ 0·55
1875	+ 0·40	+ 0·23
1876	+ 0·06	− 0·11
1877	− 0·28	− 0·45
1878	− 0·60	− 0·73
1879	− 0·85	− 0·94
1880	− 1·00	− 1·04
1881	− 1·05	
1882	− 0·98	
1883	− 0·79	
1884	− 0·51	
1885	− 0·17	
1886	+ 0·19	
1887	+ 0·53	
1888	+ 0·80	
1889	+ 0·99	
1890	+ 1·05	
1891	+ 1·00	
1892	+ 0·84	
1893	+ 0·58	
1894	+ 0·27	
1895	− 0·08	
1896	− 0·41	
1897	− 0·70	
1898	− 0·92	
1899	− 1·04	
1900	− 1·04	

TABLE IIIa.

		sec.
Jan.	1	− 0·03
	11	− 0·05
	21	− 0·07
	31	− 0·08
Feb.	10	− 0·08
	20	− 0·06
March	2	− 0·04
	12	− 0·02
	22	+ 0·01
April	1	+ 0·03
	11	+ 0·05
	21	+ 0·07
May	1	+ 0·08
	11	+ 0·08
	21	+ 0·07
	31	+ 0·05
June	10	+ 0·03
	20	+ 0·00
	30	− 0·02
July	10	− 0·05
	20	− 0·06
	30	− 0·07
Aug.	9	− 0·08
	19	− 0·07
	29	− 0·06
Sept.	8	− 0·04
	18	− 0·01
	28	+ 0·02
Oct.	8	+ 0·04
	18	+ 0·06
	28	+ 0·07
Nov.	7	+ 0·08
	17	+ 0·07
	27	+ 0·06
Dec.	7	+ 0·04
	17	+ 0·01
	27	− 0·02
	37	− 0·04

Examples of the Tables compared with the Nautical Almanac.

		Jan. 11, 1871.	Jan. 11, 1872.
Mean Time of the Transit of Vega.			
P [60] Tables I. and II.		18 32 13·31	18 33 12·45
Table III.		8·41	8·41
P [50] Table IV.	P.M.	4 38 4·81	4 38 4·81
Table IIa.		1·04+	1·03+
Table IIIa.		·05−	·05−
	A.M.	11 10 27·52	11 11 26·65
The same by Nautical Almanac.			
Apparent Place...		18 32 31·99	18 32 34·00
Retardation of Mean Time		3 2·26−	3 2·27−
		18 29 29·73	18 29 31·73
P 20 M.T. of T. of F.P. of A.	P.M.	4 40 57·79	4 41 54·92
	A.M.	11 10 27·52	11 11 26·65
Mean Time of the Transit of 3 G 1019=α Canum Venaticorum.			
P [26–7] Table I.		12 47 44·84	12 47 44·84
3 and 4 Years' Variation		8·42	11·23
Table II. interpolating		2 40·95	3 38·26
Table III. interpolating		10·35	10·35
P [50] Table IV.	P.M.	4 38 4·81	4 38 4·81
Table IIa.		1·04+	1·03+
Table IIIa.		·05−	·05−
	A.M.	5 28 50·36	5 29 50·47
The same by Nautical Almanac.			
Apparent Place of α Can. Ven.		12 49 58·71	12 50 1·69
Retardation of Mean Time		2 6·14−	2 6·15−
		12 47 52·57	12 47 55·54
P 20 M.T. of T. of F.P. of A.	P.M.	4 40 57·79	4 41 54·92
	A.M.	5 28 50·36	5 29 50·46
Mean Time of Transit of 3 Gr 1742=61′ Cygni.			
P [42–3] Table I.		20 57 32·24	20 57 32·24
3 and 4 Years' Variation		8·00	10·66
Table II.		2 41·26	3 38·29
Table III.		8·56	8·56
P [50] Table IV.	P.M.	4 38 4·81	4 38 4·81
Table IIa.		1·04+	1·03+
Table IIIa.		·05−	·05−
	P.M.	1 38 35·86	1 39 35·54
The same by Nautical Almanac.			
Apparent Place of 61′ Cygni		21 1 4·68	21 1 7·25
Retardation of Mean Time		3 26·60−	3 26·60−
		20 57 38·08	20 57 40·65
P 20 M.T. of T. of F.P. of A.	P.M.	4 40 57·79	4 41 54·92
	P.M.	1 38 35·87	1 39 35·57

47 Sussex Square, Brighton : 1869.

CORRECTIONS.

Also

P [1] last line, *instead of* A.M. *read* P.M.

To find, for a given day, the mean solar time of the apparent transit of one of the stars included in the following list.

Add together

From Table I. the Star's mean place given in column 3, with its annual variation in column 4 multiplied into the number of years since 1868; from Tables II. and III. the corrections nearest to it in date and right ascension; and from Table IV. the time for the day or the day before as the case may be; and the sum will be the mean solar time of the Star's apparent transit, true to a second without interpolation.

Example I.

Required the mean time of the apparent transit of 3 Green 66=μ Andromedæ for Oct. 20, 1871.

Table I. col. 3 . . .	0	49	17·92
3 × 3·291 col. 4 . . .			9·87
Table II. 1h Dec. 32 . .		2	40·78
Table III. 1h Oct. 18 . .			14·18
Table IV. Oct. 20 . .	10	1	26·53 P.M.
Apparent transit . . .	10	53	49·28 P.M.

Example II.

Required the mean time of the apparent transit of Vega for the same date.

Vega, Table I. and II. Dec. 32 .	18	32	13·29
Table III. Oct. 18 . . .			11·03
Table IV. Oct. 19 . . .	10	5	22·44 P.M.
Apparent transit Oct. 20 . .	4	37	46·76 A.M.

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME			North Polar Dist.			Variation	
		Right Ascension		Variation					
		h m s		Annual sec. +	Secular sec. +	° ′ ″		Annual − ″	Secular + ″
Ra 6316 G	7·3	0 0 48·69		3·065	·023	50 39 21·0		20·05	·00
R 6317 G	6·8	0 0 49·73		3·065	·023	50 35 9·8		20·05	·00
2 Gr 17 R=Andr θ	5·4	0 10 10·40		3·107	·024	52 3 5·3		20·00	·02
Ra 62 G	6·7	0 12 43·51		3·124	·026	50 0 10·5		20·03	·02
BAC 67 =Andr ρ	5·5	0 14 8·21		3·133	·024	52 45 42·8		19·99	·03
WB 561 L	7·8	0 22 47·31		3·166	·027	52 24 9·5		19·96	·05
Ra 180 G	6·3	0 33 52·70		3·220	·029	51 15 58·4		19·84	·06
Ra 185 G	6·7	0 34 45·22		3·231	·029	50 2 1·4		19·82	·07
R 198 G	7·	0 37 18·60		3·243	·029	50 2 34·4		19·79	·07
Ra 234	7·	0 45 28·35		3·279	·029	50 28 28·5		19·66	·09
3 Green 66=Andr μ	4·	0 49 17·92		3·291	·030	52 13 2·26		19·64	·11
R 284 G	7·7	0 51 56·25		3·310	·032	50 33 26·3		19·53	·11
1 Gr 69 R	6·	0 57 1·91		3·335	·031	50 42 59·8		19·42	·12

TABLE II.

Year and Dominical Letter		0h R.A. m sec	1h R.A. m sec
1868	Jan. 1	3 46·55	3 46·49
E	July 2	3 46·35	3 46·28
	Dec. 32	3 46·15	3 46·08
1869	Jan. 1	0 47·38	0 47·30
C	July 3	0 47·20	0 47·11
	Dec. 32	0 47·03	0 46·94
1870	Jan. 1	1 44·16	1 44·07
B	July 3	1 44·02	1 43·92
	Dec. 32	1 43·90	1 43·80
1871	Jan. 1	2 41·03	2 40·94
A	July 3	2 40·94	2 40·84
	Dec. 32	2 40·87	2 40·78
1872	Jan. 1	3 38·01	3 37·92
G	July 2	3 37·98	3 37·89
	Dec. 32	3 37·98	3 37·90
1873	Jan. 1	0 39·21	0 39·13
E	July 3	0 39·24	0 39·18
	Dec. 32	0 39·30	0 39·25
1874	Jan. 1	1 36·44	1 36·39
D	July 3	1 36·53	1 36·49
	Dec. 32	1 36·65	1 36·63
1875	Jan. 1	2 33·79	2 33·77
C	July 3	2 33·93	2 33·92
	Dec. 32	2 34·09	2 34·10
1876	Jan. 1	3 31·22	3 31·23
B	July 2	3 31·40	3 31·43
	Dec. 32	3 31·59	3 31·63
1877	Jan. 1	0 32·81	0 32·85
G	July 3	0 33·00	0 33·06
	Dec. 32	0 33·19	0 33·26
1878	Jan. 1	1 30·33	1 30·40
F	July 3	1 30·52	1 30·60
	Dec. 32	1 30·69	1 30·78
1879	Jan. 1	2 27·83	2 27·92
E	July 3	2 27·99	2 28·09
	Dec. 32	2 28·14	2 28·23
1880	Jan. 1	3 25·27	3 25·37
D	July 2	3 25·39	3 25·49
	Dec. 32	3 25·48	3 25·58

TABLE III.

hour 0

		0h R.A. sec	1h R.A. sec
Jan.	1	9·75	10·21
	11	9·58	10·03
	21	9·42	9·85
	31	9·27	9·68
Feb.	10	9·15	9·51
	20	9·06	9·37
Mar.	2	9·01	9·26
	12	9·01	9·18
	22	9·05	9·15
April	1	9·14	9·17
	11	9·29	9·25
	21	9·49	9·38
May	1	9·74	9·57
	11	10·03	9·81
	21	10·35	10·09
	31	10·71	10·41
June	10	11·07	10·76
	20	11·45	11·13
	30	11·83	11·51
July	10	12·19	11·89
	20	12·53	12·26
	30	12·84	12·61
Aug.	9	13·11	12 94
	19	13·34	13·23
	29	13·53	13·49
Sept.	8	13·68	13·71
	18	13·78	13·89
	28	13·83	14·03
Oct.	8	13·85	14·12
	18	13·82	14·18
	28	13·76	14·20
Nov.	7	13·67	14·18
	17	13·55	14·13
	27	13·41	14·05
Dec.	7	13·26	13·94
	17	13·09	13·80
	27	12·92	13·65
	37	12·74	13·48

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec. +	°	′	″	Annual − ″	Secular + ″
1 Gr 71	7·8	1	0	24·57	3·343	·030	51	27	11·2	19·34	·12
Ra 398 *	7·2	1	11	8·86	3·395	·031	50	43	52·0	19·10	·14
BAC 409	6·	1	15	55·65	3·401	·030	52	58	26·9	18·98	·16
R 434 G	6·9	1	19	55·01	3·441	·034	50	20	58·3	18·84	·17
Ra 497 G =Andr τ	5·5	1	32	32·77	3·513	·034	50	5	32·5	18·43	·20
Ra 508 G	7·1	1	34	34·36	3·506	·032	50	17	24·8	18·36	·20
BAC 544 W.B.	6·	1	40	35·43	3·506	·031	52	42	18·0	18·15	·21
WB 1218 L	8·	1	52	5·84	3·554	·034	52	2	51·9	17·69	·25

* By Groombridge R.A. 1 11 8·29

TABLE II.

Year and Dominical Letter		1h R.A. m sec	2h R.A. m sec
1868	Jan. 1	3 46·49	3 46·42
E	July 2	3 46·28	3 46·19
	Dec. 32	3 46·08	3 45·98
1869	Jan. 1	0 47·30	0 47·21
C	July 3	0 47·11	0 47·01
	Dec. 32	0 46·94	0 46·83
1870	Jan. 1	1 44·07	1 43·97
B	July 3	1 43·92	1 43·82
	Dec. 32	1 43·80	1 43·70
1871	Jan. 1	2 40·94	2 40·84
A	July 3	2 40·84	2 40·75
	Dec. 32	2 40·78	2 40·70
1872	Jan. 1	3 37·92	3 37·84
G	July 2	3 37·89	3 37·83
	Dec. 32	3 37·90	3 37·85
1873	Jan. 1	0 39·13	0 39·08
E	July 3	0 39·18	0 39·14
	Dec. 32	0 39·25	0 39·23
1874	Jan. 1	1 36·39	1 36·37
D	July 3	1 36·49	1 36·49
	Dec. 32	1 36·63	1 36·64
1875	Jan. 1	2 33·77	2 33·78
C	July 3	2 33·92	2 33·95
	Dec. 32	2 34·10	2 34·14
1876	Jan. 1	3 31·23	3 31·28
B	July 2	3 31·43	3 31·48
	Dec. 32	3 31·63	3 31·70
1877	Jan. 1	0 32·85	0 32·92
G	July 3	0 33·06	0 33·14
	Dec. 32	0 33·26	0 33·35
1878	Jan. 1	1 30·40	1 30·49
F	July 3	1 30·60	1 30·69
	Dec. 32	1 30·78	1 30·88
1879	Jan. 1	2 27·92	2 28·02
E	July 3	2 28·09	2 28·19
	Dec. 32	2 28·23	2 28·33
1880	Jan. 1	3 25·37	3 25·47
D	July 2	3 25·49	3 25·58
	Dec. 32	3 25·58	3 25·66

TABLE III.

hour 1

	1h R.A. sec	2h R.A. sec
Jan. 1	10·21	10·65
11	10·03	10·49
21	9·85	10·31
31	9·68	10·13
Feb. 10	9·51	9·93
20	9·37	9·75
Mar. 2	9·26	9·58
12	9·18	9·45
22	9·15	9·35
April 1	9·17	9·30
11	9·25	9·31
21	9·38	9·37
May 1	9·57	9·49
11	9·81	9 66
21	10·09	9·89
31	10·41	10·17
June 10	10·76	10·48
20	11·13	10·83
30	11·51	11·20
July 10	11·89	11·58
20	12·26	11·96
30	12·61	12·34
Aug. 9	12·94	12·70
19	13·23	13·04
29	13·49	13·35
Sept. 8	13·71	13·64
18	13·89	13·89
28	14·03	14·10
Oct. 8	14·12	14·28
18	14·18	14·42
28	14·20	14·52
Nov. 7	14·18	14·58
17	14·13	14·60
27	14·05	14·59
Dec. 7	13·94	14·54
17	13·80	14·45
27	13·65	14·33
37	13·48	14·19

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME			North Polar Dist.		Variation	
		Right Ascension	Variation					
		h m s	Annual sec. +	Secular sec. +	° ′ ″		Annual − ″	Secular + ″
BAC 649	5·5	2 0 12·34	3·588	·032	52 46	3·9	17·31	·26
R 628 G	7·1	2 2 32·82	3·603	·034	51 35	5·3	17·23	·27
R 629 G	7·3	2 2 33·67	3·603	·034	51 34	52·0	17·23	·27
R 682 WB	6·8	2 11 8·68	3·652	·031	50 46	28·8	16·82	·30
1 G 213 Ra	6·	2 21 22·65	3·680	·033	51 27	11·5	16·32	·31
Ra 725	7·6	2 21 39·64	3·675	·033	51 38	8·7	16·32	·32
R 742 WB	6·8	2 26 49·07	3·711	·033	50 54	52·9	16·06	·31
1 G 229 Rad	5·	2 33 30·44	3·752	·034	50 21	57·6	15·52	·34
3 G 188 Ra	5·4	2 41 49·08	3·756	·033	52 13	33·7	15·15	·36
BAC 888	6·5	2 44 56·04	3·749	·032	52 12	8·2	14·98	·36
Ra 840 A	6·	2 49 12·95	3·766	·031	51 55	3·1	14·80	·36
1 Gr 250 Ra=Per π	5·	2 49 51·92	3·804	·033	50 52	3·6	14·71	·37
Ra 855 G	6·9	2 53 0·72	3·787	·032	51 38	47·5	14·58	·37
3 Gr 199 Ra=Pers ρ	4·	2 56 14·67	3·812	·033	51 40	24·8	14·24	·39

Year and Dominical Letter		2h R.A. m sec	3h R.A. m. sec
1868	Jan. 1	3 46·42	3 46·31
E	July 2	3 46·19	3 46·08
	Dec. 32	3 45·98	3 45·87
1869	Jan. 1	0 47·21	0 47·10
C	July 3	0 47·01	0 46·90
	Dec. 32	0 46·83	0 46·73
1870	Jan. 1	1 43·97	1 43·87
B	July 3	1 43·82	1 43·72
	Dec. 32	1 43·70	1 43·62
1871	Jan. 1	2 40·84	2 40·75
A	July 3	2 40·75	2 40·68
	Dec. 32	2 40·70	2 40·64
1872	Jan. 1	3 37·84	3 37·78
G	July 2	3 37·83	3 37·78
	Dec. 32	3 37·85	3 37·82
1873	Jan. 1	0 39·08	0 39·05
E	July 3	0 39·14	0 39·13
	Dec. 32	0 39·23	0 39·24
1874	Jan. 1	1 36·37	1 36·37
D	July 3	1 36·49	1 36·51
	Dec. 32	1 36·64	1 36·68
1875	Jan. 1	2 33·78	2 33·82
C	July 3	2 33·95	2 34·01
	Dec. 32	2 34·14	2 34·21
1876	Jan. 1	3 31·28	3 31·35
B	July 2	3 31·48	3 31·57
	Dec. 32	3 31·70	3 31·79
1877	Jan. 1	0 32·92	0 33·02
G	July 3	0 33·14	0 33·24
	Dec. 32	0 33·35	0 33·46
1878	Jan. 1	1 30·49	1 30·60
F	July 3	1 30·69	1 30·80
	Dec. 32	1 30·88	1 30·99
1879	Jan. 1	2 28·02	2 28·12
E	July 3	2 28·19	2 28·29
	Dec. 32	2 28·33	2 28·42
1880	Jan. 1	3 25·47	3 25·56
D	July 2	3 25·58	3 25·67
	Dec. 32	3 25·66	3 25·74

		2h R.A. sec	3h R.A. sec
Jan.	1	10·65	11·06
	11	10·49	10·93
	21	10·31	10·77
	31	10·13	10·59
Feb.	10	9·93	10·39
	20	9·75	10·18
Mar.	2	9·58	9·98
	12	9·45	9·80
	22	9·35	9·65
Apr.	1	9·30	9·54
	11	9·31	9·47
	21	9·37	9·46
May	1	9·49	9·51
	11	9·66	9·62
	21	9·89	9·78
	31	10·17	10·00
June	10	10·48	10·26
	20	10·83	10·57
	30	11·20	10·91
July	10	11·58	11·27
	20	11·96	11·64
	30	12·34	12·03
Aug.	9	12·70	12·41
	19	13·04	12·78
	29	13·35	13·13
Sept.	8	13·64	13·47
	18	13·89	13·77
	28	14·10	14·05
Oct.	8	14·28	14·30
	18	14·42	14·52
	28	14·52	14·70
Nov.	7	14·58	14·84
	17	14·60	14·95
	27	14·59	15·01
Dec.	7	14·54	15·03
	17	14·45	15·00
	27	14·33	14·94
	37	14·19	14·83

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME				North Polar Dist.			Variation	
		Right Ascension			Variation					
		h	m	s	Annual sec. +	Secular sec. +	°	′	″	Annual − ″	Secular + ″
Ra 890 BAC=Per ω	4·9	3	2	16·71	3·837	·032	50	53	31·7	14·00	·40
Ra 917 G	6·5	3	8	41·81	3·850	·031	51	12	14·7	13·60	·41
WB 392 L	7·	3	19	16·92	3·912	·033	50	17	23·5	12·90	·44
Ra 1004 G	6·4	3	24	19·84	3·919	·033	50	32	51·5	12·55	·45
BAC 1123	6·	3	31	59·29	3·896	·027	52	50	48·8	12·09	·45
Ra 1054 G	7·	3	36	21·06	3·915	·027	51	44	32·8	11·70	·48
1 Gr 336 Ra	3·4	3	48	22·55	3·993	·027	50	22	28·9	10·79	·49
Ra 1108 WB	6·5	3	49	5·01	3·955	·027	51	32	28·6	10 79	·48
R 1114 G	6·6	3	50	15·94	3·957	·026	51	33	34·9	10·69	·50
BAC 1264	7·5	3	58	7·80	3·970	·024	52	16	34·5	9·86	·50
BAC 1268	6·5	3	58	53·15	3·939	·024	52	37	16·5	9·91	·50
BAC 1269	5·5	3	59	9·97	3·974	·024	52	18	31·5	9·83	·50

TABLE II.

Year and Dominical Letter		3h R.A. m sec	4h R.A. m sec
1868	Jan. 1	3 46·31	3 46·20
E	July 2	3 46·08	3 45·97
	Dec. 32	3 45·87	3 45·75
1869	Jan. 1	0 47·10	0 46·98
C	July 3	0 46·90	0 46·79
	Dec. 32	0 46·73	0 46·63
1870	Jan. 1	1 43·87	1 43·76
B	July 3	1 43·72	1 43·64
	Dec. 32	1 43·62	1 43·54
1871	Jan. 1	2 40·75	2 40·68
A	July 3	2 40·68	2 40·62
	Dec. 32	2 40·64	2 40·60
1872	Jan. 1	3 37·78	3 37·74
G	July 2	3 37·78	3 37·76
	Dec. 32	3 37·82	3 37·82
1873	Jan. 1	0 39·05	0 39·05
E	July 3	0 39·13	0 39·15
	Dec. 32	0 39·24	0 39·27
1874	Jan. 1	1 36·37	1 36·41
D	July 3	1 36·51	1 36·57
	Dec. 32	1 36·68	1 36·75
1875	Jan. 1	2 33·82	2 33·89
C	July 3	2 34·01	2 34·10
	Dec. 32	2 34·21	2 34·31
1876	Jan. 1	3 31·35	3 31·45
B	July 2	3 31·57	3 31·68
	Dec. 32	3 31·79	3 31·91
1877	Jan. 1	0 33·02	0 33·13
G	July 3	0 33·24	0 33·36
	Dec. 32	0 33·46	0 33·57
1878	Jan. 1	1 30·60	1 30·71
F	July 3	1 30·80	1 30·91
	Dec. 32	1 30·99	1 31·09
1879	Jan. 1	2 28·12	2 28·23
E	July 3	2 28·29	2 28·38
	Dec. 32	2 28·42	2 28·51
1880	Jan. 1	3 25·56	3 25·65
D	July 2	3 25·67	3 25·74
	Dec. 32	3 25·74	3 25·79

TABLE III.

hour 3

		3h R.A. sec	4h R.A. sec
Jan.	1	11·06	11·39
	11	10·93	11·32
	21	10·77	11·19
	31	10·59	11·04
Feb.	10	10·39	10·84
	20	10·18	10·64
Mar.	2	9·98	10·42
	12	9·80	10·21
	22	9·65	10·01
Apr.	1	9·54	9·85
	11	9·47	9·72
	21	9·46	9·65
May	1	9·51	9·63
	11	9·62	9·67
	21	9·78	9·76
	31	10·00	9·91
June	10	10·26	10·12
	20	10·57	10·37
	30	10·91	10·66
July	10	11·27	10·99
	20	11·64	11·34
	30	12·03	11·70
Aug.	9	12·41	12·08
	19	12·78	12·46
	29	13 13	12·83
Sept.	8	13·47	13·20
	18	13·77	13·55
	28	14·05	13·88
Oct.	8	14·30	14·19
	18	14·52	14·48
	28	14·70	14·73
Nov.	7	14·84	14·95
	17	14·95	15·13
	27	15·01	15·27
Dec.	7	15·03	15·37
	17	15·00	15·41
	27	14·94	15·41
	37	14·83	15·36

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MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME			North Polar Dist.	Variation	
		Right Ascension	Variation				
		h m s	Annual sec. +	Secular sec. +	° ′ ″	Annual − ″	Secular + ″
WB 188–9–10	8·	4 10 13·03	4·023	·025	51 1 35·7	9·18	·52
WB 461–2	7·8	4 21 40·28	4·073	·024	50 16 48·0	8·27	·54
WB 693–4	6·	4 32 6·89	4·032	·020	51 58 31·4	7·43	·55
BAC 1476	6·	4 40 15·56	4·015	·017	52 44 50·1	6·82	·55
BAC 1530	5·	4 49 30·28	4·050	·015	52 18 43·3	5·91	·56
Ra 1368 G	6·2	4 50 26·41	4·101	·016	50 48 31·1	5·92	·57
Ra 1369 G	6·	4 50 29·86	4·110	·016	50 32 54·0	5·91	·57

Year and Dominical Letter		4h R.A. m sec	5h R.A. m sec
1868	Jan. 1	3 46·20	3 46·07
E	July 2	3 45·97	3 45·85
	Dec. 32	3 45·75	3 45·64
1869	Jan. 1	0 46·98	0 46·87
C	July 3	0 46·79	0 46·69
	Dec. 32	0 46·63	0 46·54
1870	Jan. 1	1 43·76	1 43·68
B	July 3	1 43·64	1 43·56
	Dec. 32	1 43·54	1 43·49
1871	Jan. 1	2 40·68	2 40·62
A	July 3	2 40·62	2 40·58
	Dec. 32	2 40·60	2 40·59
1872	Jan. 1	3 37·74	3 37·72
G	July 2	3 37·76	3 37·77
	Dec. 32	3 37·82	3 37·85
1873	Jan. 1	0 39·05	0 39·08
E	July 3	0 39·15	0 39·19
	Dec. 32	0 39·27	0 39·34
1874	Jan. 1	1 36·41	1 36·48
D	July 3	1 36·57	1 36·65
	Dec. 32	1 36·75	1 36·85
1875	Jan. 1	2 33·89	2 33·99
C	July 3	2 34·10	2 34·20
	Dec. 32	2 34·31	2 34·43
1876	Jan. 1	3 31·45	3 31·56
B	July 2	3 31·68	3 31·80
	Dec. 32	3 31·91	3 32·03
1877	Jan. 1	0 33·13	0 33·26
G	July 3	0 33·36	0 33·48
	Dec. 32	0 33 57	0 33·69
1878	Jan. 1	1 30·72	1 30·83
F	July 3	1 30·91	1 31·02
	Dec. 32	1 31·09	1 31·19
1879	Jan. 1	2 28·23	2 28·33
E	July 3	2 28·38	2 28·47
	Dec. 32	2 28·51	2 28·58
1880	Jan. 1	3 25·65	3 25·71
D	July 2	3 25·74	3 25·79
	Dec. 32	3 25·79	3 25·82

		4h R.A. sec	5h R.A. sec
Jan.	1	11·39	11·63
	11	11·32	11·62
	21	11·19	11·55
	31	11·04	11·43
Feb.	10	10·84	11·27
	20	10·64	11·08
Mar.	2	10·42	10·86
	12	10·21	10·65
	22	10·01	10·42
Apr.	1	9·85	10·22
	11	9·72	10·05
	21	9·65	9·92
May	1	9·63	9·84
	11	9·67	9·81
	21	9·76	9·83
	31	9·91	9·92
June	10	10·12	10·05
	20	10·37	10·24
	30	10·66	10·48
July	10	10·99	10·75
	20	11·34	11·06
	30	11·70	11·39
Aug.	9	12·08	11·75
	19	12·46	12·12
	29	12·83	12·49
Sept.	8	13·20	12·86
	18	13·55	13·24
	28	13·88	13·60
Oct.	8	14·19	13·95
	18	14·48	14·29
	28	14·73	14·60
Nov.	7	14·95	14·89
	17	15·13	15·14
	27	15·27	15·36
Dec.	7	15·37	15·53
	17	15·41	15·65
	27	15·41	15·72
	37	15·36	15·74

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME				North Polar Dist.			Variation	
		Right Ascension			Variation					
		h	m	s	Annual sec. +	Secular sec. +	°	′	″	Annual − ″	Secular + ″
Ra 1426 G = Aur μ	5·4	5	3	34·08	4·085	·013	51	40	29·4	4·75	·58
3 Gr 384 Rad = Aur λ	5·	5	9	0·72	4·198	·014	50	1	19·5	3·64	·60
BAC 1663 = Aur σ	5·5	5	14	49·40	4·063	·010	52	44	27·6	3·84	·58
R 1491 G	6·9	5	20	41·19	4·153	·007	50	16	48·4	3·33	·62
R 1493 G	7·7	5	20	58·06	4·162	·008	50	4	29·9	3·31	·61
Ra 1496 *	7·1	5	21	30·67	4·097	·007	51	47	2·3	3·26	·60
R 1515 G	7·4	5	26	55·97	4·102	·006	51	44	40·7	2·79	·61
R 1538 G	7·9	5	32	20·75	4·101	·006	51	52	22·5	2·32	·60
R 1541	7·4	5	32	49·17	4·101	·006	51	52	15·9	2·28	·60
Ra 1558 G	6·8	5	38	45·42	4·159	·005	50	30	55·7	1·76	·61
Ra 1559 G	5·	5	39	6·14	4·142	·005	50	52	2·3	1·73	·61
BAC 1844 = Aur υ	5·5	5	41	6·31	4·080	·004	52	44	8·6	1·53	·59
Rad 1564 G = Aur ν	4·5	5	41	24·50	4·145	·004	50	53	36·9	1·56	·61
3 G 447 BAC = Aur θ	3·	5	49	45·83	4·079	·004	52	47	59·7	0·69	·60
R 1609 WB	7·7	5	51	57·12	4·122	·001	51	32	53·4	0·61	·60
R 1611 WB	7·2	5	52	0·46	4·129	·001	51	17	13·8	0·60	·60
Ra 1622 WB	6·9	5	54	35·23	4·125	·001	51	25	27·0	0·38	·60
Ra 1624 WB	6·4	5	55	0·98	4·099	·001	52	2	1·3	0·26	·60
Ra 1625 G	5·9	5	56	30·53	4·122	·001	51	30	30·3	0·21	·60
R 1634 BAC	6·8	5	57	28·96	4·111	·001	51	54	27·4	0·06	·60

* Ra 1496 RA. by G 30·18; by WB 30·26; by L 30·05

Year and Dominical Letter		5h R.A. m sec	6h R.A. m sec
1868	Jan. 1	3 46·07	3 45·95
E	July 2	3 45·85	3 45·73
	Dec. 32	3 45·64	3 45·54
1869	Jan. 1	0 46·87	0 46·76
C	July 3	0 46·69	0 46·60
	Dec. 32	0 46·54	0 46·47
1870	Jan. 1	1 43·68	1 43·60
B	July 3	1 43·56	1 43·51
	Dec. 32	1 43·49	1 43·45
1871	Jan. 1	2 40·62	2 40·59
A	July 3	2 40·58	2 40·57
	Dec. 32	2 40·59	2 40·60
1872	Jan. 1	3 37·72	3 37·73
G	July 2	3 37·77	3 37·80
	Dec. 32	3 37·85	3 37·90
1873	Jan. 1	0 39·08	0 39·13
E	July 3	0 39·19	0 39·26
	Dec. 32	0 39·34	0 39·43
1874	Jan. 1	1 36·48	1 36·56
D	July 3	1 36·65	1 36·75
	Dec. 32	1 36·85	1 36·96
1875	Jan. 1	2 33·99	2 34·10
C	July 3	2 34·20	2 34·32
	Dec. 32	2 34·43	2 34·55
1876	Jan. 1	3 31·56	3 31·69
B	July 2	3 31·80	3 31·92
	Dec. 32	3 32·03	3 32·15
1877	Jan. 1	0 33·26	0 33·38
G	July 3	0 33·48	0 33·60
	Dec. 32	0 33·69	0 33·80
1878	Jan. 1	1 30·83	1 30·94
F	July 3	1 31·02	1 31·12
	Dec. 32	1 31·19	1 31·28
1879	Jan. 1	2 28·33	2 28·41
E	July 3	2 28·47	2 28·54
	Dec. 32	2 28·58	2 28·63
1880	Jan. 1	3 25·71	3 25·76
D	July 2	3 25·79	3 25·81
	Dec. 32	3 25·82	3 25·83

		5h R.A. sec	6h R.A. sec
Jan.	1	11·63	11·77
	11	11·62	11·82
	21	11·55	11·82
	31	11·43	11·76
Feb.	10	11·27	11·64
	20	11·08	11·48
Mar.	2	10·86	11·29
	12	10·65	11·07
	22	10·42	10·85
Apr.	1	10·22	10·63
	11	10·05	10·43
	21	9·92	10·25
May	1	9·84	10·12
	11	9·81	10·03
	21	9·83	9·99
	31	9·92	10·01
June	10	10·05	10·08
	20	10·24	10·19
	30	10·48	10·36
July	10	10·75	10·58
	20	11·06	10·83
	30	11·39	11·11
Aug.	9	11·75	11·42
	19	12·12	11·76
	29	12·49	12·11
Sept.	8	12·86	12·48
	18	13·24	12·85
	28	13·60	13·23
Oct.	8	13·95	13·60
	18	14·29	13·97
	28	14·60	14·33
Nov.	7	14·89	14·67
	17	15·14	14·98
	27	15·36	15·27
Dec.	7	15·53	15·51
	17	15·65	15·71
	27	15·72	15·85
	37	15·74	15·94

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec. −	°	′	″	Annual + ″	Secular + ″
R 1676 WB	7·7	6	4	8·65	4·168	·003	50	17	37·6	0·46	·61
R 1694 G	6·9	6	7	33·79	4·161	·001	50	29	0·0	0·76	·61
R 1698	7·6	6	8	34·20	4·112	·002	51	43	4·3	0·85	·60
R 1702 G	7·2	6	9	37·14	4·122	·000	51	30	53·7	0·94	·60
R 1758	7·1	6	23	28 86	4·154	·009	50	27	31·5	2·15	·60
R 1761 G	6·8	6	24	13·26	4·103	·006	51	49	40·4	2·22	·60
Ra 1763 G	7·9	6	24	33·40	4·119	·009	51	21	46·2	2·25	·61
R 1768 G	5·7	6	26	24·68	4·115	·009	51	27	3·1	2·41	·60
Ra 1777 G	5·9	6	28	26·84	4·152	·006	50	29	42·6	2·59	·62
Ra 1794 G	7·1	6	32	23·87	4·130	·009	50	58	58·7	2·93	·59
Ra 1827 G	6·4	6	42	50·43	4·133	·011	50	58	36·7	3·83	·58
Ra 1828 WB	6·4	6	43	3·87	4·106	·011	51	24	1·3	4·00	·58
Ra 1830 G	6·5	6	43	47·60	4·108	·009	51	20	11·5	3·93	·60
R 1840 G	6·9	6	45	25·63	4·084	·011	51	55	13·6	4·06	·59
R 1852 G	7·9	6	48	16·27	4·085	·011	51	50	21·2	4·29	·57
Rad 1856 G	6·2	6	48	55·97	4·087	·011	51	46	9·6	4·45	·58

Year and Dominical Letter		6h R.A. m	sec	7h R.A. m	sec
1868	Jan. 1	3	45·95	3	45·83
E	July 2	3	45·73	3	45·63
	Dec. 32	3	45·54	3	45·45
1869	Jan. 1	0	46·76	0	46·68
C	July 3	0	46·60	0	46·53
	Dec. 32	0	46·47	0	46·42
1870	Jan. 1	1	43·60	1	43·55
B	July 3	1	43·51	1	43·48
	Dec. 32	1	43·45	1	43·44
1871	Jan. 1	2	40·59	2	40·58
A	July 3	2	40·57	2	40·59
	Dec. 32	2	40·60	2	40·63
1872	Jan. 1	3	37·73	3	37·77
G	July 2	3	37·80	3	37·85
	Dec. 32	3	37·90	3	37·97
1873	Jan. 1	0	39·13	0	39·20
E	July 3	0	39·26	0	39·35
	Dec. 32	0	39·43	0	39·53
1874	Jan. 1	1	36·56	1	36·67
D	July 3	1	36·75	1	36·86
	Dec. 32	1	36·96	1	37·08
1875	Jan. 1	2	34·10	2	34·22
C	July 3	2	34·32	2	34·45
	Dec. 32	2	34·55	2	34·68
1876	Jan. 1	3	31·69	3	31·82
B	July 2	3	31·92	3	32·05
	Dec. 32	3	32·15	3	32·27
1877	Jan. 1	0	33·38	0	33·50
G	July 3	0	33·60	0	33·71
	Dec. 32	0	33·80	0	33·90
1878	Jan. 1	1	30·94	1	31·04
F	July 3	1	31·12	1	31·20
	Dec. 32	1	31·28	1	31·34
1879	Jan. 1	2	28·41	2	28·48
E	July 3	2	28·54	2	28·58
	Dec. 32	2	28·63	2	28·65
1880	Jan. 1	3	25·76	3	25·79
D	July 2	3	25·81	3	25·82
	Dec. 32	3	25·83	3	25·81

		6h R.A. sec	7h R.A. sec
Jan.	1	11·77	11·78
	11	11·82	11·91
	21	11·82	11·98
	31	11·76	11·99
Feb.	10	11·64	11·93
	20	11·48	11·82
Mar.	2	11·29	11·66
	12	11·07	11·48
	22	10·85	11·27
Apr.	1	10·63	11·04
	11	10·43	10·83
	21	10·25	10·63
May	1	10·12	10·46
	11	10·03	10·32
	21	9·99	10·23
	31	10·01	10·18
June	10	10·08	10·18
	20	10·19	10·24
	30	10·36	10·33
July	10	10·58	10·48
	20	10·83	10·66
	30	11·11	10·88
Aug.	9	11·42	11·14
	19	11·76	11·43
	29	12·11	11·74
Sept.	8	12·48	12·07
	18	12·85	12·42
	28	13·23	12·79
Oct.	8	13·60	13·17
	18	13·97	13·55
	28	14·33	13·93
Nov.	7	14·67	14·31
	17	14·98	14·67
	27	15·27	15·01
Dec.	7	15·51	15·31
	17	15·71	15·58
	27	15·85	15·80
	37	15·94	15·96

TABLE I.

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Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME			North Polar Dist.			Variation	
		Right Ascension	Variation						
		h m s	Annual sec. +	Secular sec. −	° ′ ″			Annual + ″	Secular + ″
1 Gr 637 Rad	5·	7 1 25·13	4·130	·014	50	28	2·6	5·45	·58
R 1919 G	7·	7 7 31·25	4·097	·017	50	53	30·4	5·93	·57
R 1926 WB	7·1	7 8 42·18	4·088	·017	51	5	32·3	6·03	·57
R 1937 G	6·7	7 12 1·45	4·094	·020	50	45	26·9	6·32	·58
R 1938 G	5·1	7 12 2·40	4·015	·017	52	59	37·9	6·31	·56
Ra 1958 WB	7·1	7 17 24·12	4·075	·020	51	4	18·4	6·75	·55
R 1969	7·8	7 19 49·52	4·063	·020	51	17	28·0	6·96	·57
R 1970 G	7·2	7 20 2·46	4·053	·020	51	33	33·8	6·97	·55
Ra 1973 G	6·9	7 21 45·22	4·077	·020	50	49	45·1	7·11	·55
R 1994 G	7·3	7 27 59·82	4·044	·020	51	26	53·1	7·61	·53
Ra 1999 G	8·	7 28 38·33	4·045	·020	51	22	19·7	7·68	·55
Ra 2006 G	6·2	7 30 7·35	4·044	·020	51	21	23·3	7·80	·55
WB 1083 L	6·	7 36 35·40	4·006	·019	52	9	59·0	8·32	·53
WB 1297 L	8·	7 45 9·98	3·979	·020	52	27	44·3	9·00	·52
WB 1490 L	7·	7 53 26·69	3·961	·021	52	29	52·4	9·64	·51

Year and Dominical Letter		7h R.A. m sec	8h R.A. m. sec
1868	Jan. 1	3 45·83	3 45·74
E	July 2	3 45·63	3 45·55
	Dec. 32	3 45·45	3 45·38
1869	Jan. 1	0 46·68	0 46·61
C	July 3	0 46·53	0 46·48
	Dec. 32	0 46·42	0 46·39
1870	Jan. 1	1 43·55	1 43·53
B	July 3	1 43·48	1 43·47
	Dec. 32	1 43·44	1 43·46
1871	Jan. 1	2 40·58	2 40·60
A	July 3	2 40·59	2 40·62
	Dec. 32	2 40·63	2 40·69
1872	Jan. 1	3 37·77	3 37·82
G	July 2	3 37·85	3 37·93
	Dec. 32	3 37·97	3 38·06
1873	Jan. 1	0 39·20	0 39·29
E	July 3	0 39·35	0 39·45
	Dec. 32	0 39·53	0 39·64
1874	Jan. 1	1 36·67	1 36·78
D	July 3	1 36·86	1 36·98
	Dec. 32	1 37·08	1 37·20
1875	Jan. 1	2 34·22	2 34·34
C	July 3	2 34·45	2 34·57
	Dec. 32	2 34·68	2 34·80
1876	Jan. 1	3 31·82	3 31·93
B	July 2	3 32·05	3 32·16
	Dec. 32	3 32·27	3 32·37
1877	Jan. 1	0 33·50	0 33·60
G	July 3	0 33·71	0 33·80
	Dec. 32	0 33·90	0 33·97
1878	Jan. 1	1 31·04	1 31·11
F	July 3	1 31·20	1 31·26
	Dec. 32	1 31·34	1 31·38
1879	Jan. 1	2 28·48	2 28·52
E	July 3	2 28·58	2 28·60
	Dec. 32	2 28·65	2 28·65
1880	Jan. 1	3 25·79	3 25·78
D	July 2	3 25·82	3 25·79
	Dec. 32	3 25·81	3 25·76

	7h R.A. sec	8h R.A. sec
Jan. 1	11·78	11·68
11	11·91	11·88
21	11·98	12·02
31	11·99	12·10
Feb. 10	11·93	12·12
20	11·82	12·07
Mar. 2	11·66	11·97
12	11·48	11·82
22	11·27	11·64
Apr. 1	11·04	11·44
11	10·83	11·23
21	10·63	11·03
May 1	10·46	10·83
11	10·32	10·67
21	10·23	10·53
31	10·18	10·43
June 10	10·18	10·37
20	10·24	10·36
30	10·33	10·39
July 10	10·48	10·46
20	10·66	10·57
30	10·88	10·72
Aug. 9	11·14	10·91
19	11·43	11·13
29	11·74	11·39
Sept. 8	12·07	11·67
18	12·42	11·98
28	12·79	12·32
Oct. 8	13·17	12·67
18	13·55	13·05
28	13·93	13·43
Nov. 7	14·31	13·82
17	14·67	14·21
27	15·01	14·59
Dec. 7	15·31	14·95
17	15·58	15·27
27	15 80	15·55
37	15·96	15·78

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Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME			North Polar Dist.			Variation	
		Right Ascension	Variation						
		h m s	Annual sec. +	Secular sec. −	° ′ ″			Annual + ″	Secular + ″
Ra 2096 G	6·5	8 1 17·26	3·994	·026	50	52	43·2	10·24	·51
WB 354 L	8·	8 15 26·25	3·919	·025	52	11	8·7	11·28	·47
Ra 2164 G	6·3	8 22 57·31	3·917	·029	51	31	56·9	11·81	·45
WB 688 L	7·8	8 28 23·79	3·875	·026	52	31	17·2	12·20	·45
R 2206 G	7·3	8 39 3·63	3·882	·031	51	10	14·1	12·93	·43
Ra 2248 G	6·4	8 50 39·66	3·826	·031	51	53	1·8	13·69	·41
Ra 2255 G	7·4	8 52 24·14	3·849	·034	50	49	36·2	13·80	·40
R 2258 G	7·4	8 53 36·77	3·822	·034	51	38	1·8	13·88	·40
Ra 2260 WB & L	7·	8 53 52·86	3·848	·032	50	44	16·6	13·89	·39
Ra 2269 WB	7·9	8 56 0·0	3·831	·034	51	2	8·7	14·03	·39
3 Gr 689 Rad	5·	8 56 39·43	3·840	·030	51	1	20·5	14·13	·39

Year and Dominical Letter		8h R.A. m sec	9h R.A. m sec
1868	Jan. 1	3 45·74	3 45·66
E	July 2	3 45·55	3 45·49
	Dec. 32	3 45·38	3 45·35
1869	Jan. 1	0 46·61	0 46·57
C	July 3	0 46·48	0 46·47
	Dec. 32	0 46·39	0 46·39
1870	Jan. 1	1 43·53	1 43·53
B	July 3	1 43·47	1 43·50
	Dec. 32	1 43·46	1 43·50
1871	Jan. 1	2 40·60	2 40·64
A	July 3	2 40·62	2 40·68
	Dec. 32	2 40·69	2 40·76
1872	Jan. 1	3 37·82	3 37·90
G	July 2	3 37·93	3 38·02
	Dec. 32	3 38·06	3 38·16
1873	Jan. 1	0 39·29	0 39·39
E	July 3	0 39·45	0 39·56
	Dec. 32	0 39·64	0 39·75
1874	Jan. 1	1 36·78	1 36·89
D	July 3	1 36·98	1 37·10
	Dec. 32	1 37·20	1 37·32
1875	Jan. 1	2 34·34	2 34·46
C	July 3	2 34·57	2 34·68
	Dec. 32	2 34·80	2 34·90
1876	Jan. 1	3 31·93	3 32·04
B	July 2	3 32·16	3 32·25
	Dec. 32	3 32·37	3 32·45
1877	Jan. 1	0 33·60	0 33·68
G	July 3	0 33·80	0 33·86
	Dec. 32	0 33·97	0 34·02
1878	Jan. 1	1 31·11	1 31·16
F	July 3	1 31·26	1 31·29
	Dec. 32	1 31·38	1 31·39
1879	Jan. 1	2 28·52	2 28·53
E	July 3	2 28·60	2 28·59
	Dec. 32	2 28·65	2 28·62
1880	Jan. 1	3 25·78	3 25·76
D	July 2	3 25·79	3 25·75
	Dec. 32	3 25·76	3 25·70

	8h R.A.' sec	9h R.A. sec
Jan. 1	11·68	11·47
11	11·88	11·74
21	12·02	11·95
31	12·10	12·10
Feb. 10	12·12	12·19
20	12·07	12·21
Mar. 2	11·97	12·17
12	11·82	12·08
22	11·64	11·95
Apr. 1	11·44	11·79
11	11·23	11·60
21	11·03	11·41
May 1	10·83	11·21
11	10·67	11·03
21	10·53	10·87
31	10·43	10·73
June 10	10·37	10·63
20	10·36	10·55
30	10·39	10·52
July 10	10·46	10·52
20	10·57	10·56
30	10·72	10·64
Aug. 9	10·91	10·75
19	11·13	10·90
29	11·39	11·08
Sept. 8	11·67	11·30
18	11·98	11·56
28	12·32	11·84
Oct. 8	12·67	12·16
18	13·05	12·50
28	13·43	12·87
Nov. 7	13·82	13·25
17	14·21	13·65
27	14·59	14·04
Dec. 7	14·95	14·43
17	15·27	14·80
27	15·55	15·14
37	15·78	15·43

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec. −	°	′	″	Annual + ″	Secular + ″
Ra 2294	6·8	9	5	8·71	3·806	·034	50	51	1·0	14·60	·39
2 Gre 664 BAC	4·	9	9	7·10	3·747	·031	52	38	25·4	14·87	·37
Ra 2311 G	6·4	9	11	12·22	3·774	·034	51	15	17·4	14·95	·36
3 G 732 BAC	6·	9	23	51·22	3·696	·030	52	55	50·0	15·71	·33
R 2379 G	7·1	9	31	37·35	3·719	·034	50	26	49·6	16·10	·34
Ra 2405 WB	6·6	9	42	45·56	3·654	·034	51	28	3·3	16·66	·31
Ra 2434	7·0	9	54	21·74	3·611	·034	51	20	16·0	17·20	·28

Year and Dominical Letter		9h R.A. m sec	10h R.A. m sec
1868	Jan. 1	3 45·66	3 45·62
E	July 2	3 45·49	3 45·46
	Dec. 32	3 45·35	3 45·34
1869	Jan. 1	0 46·57	0 46·57
C	July 3	0 46·47	0 46·48
	Dec. 32	0 46·39	0 46·42
1870	Jan. 1	1 43·53	1 43·56
B	July 3	1 43·50	1 43·54
	Dec. 32	1 43·50	1 43·56
1871	Jan. 1	2 40·64	2 40·70
A	July 3	2 40·68	2 40·76
	Dec. 32	2 40·76	2 40·85
1872	Jan. 1	3 37·90	3 37·99
G	July 2	3 38·02	3 38·11
	Dec. 32	3 38·16	3 38·26
1873	Jan. 1	0 39·39	0 39·49
E	July 3	0 39·56	0 39·67
	Dec. 32	0 39·75	0 39·86
1874	Jan. 1	1 36·89	1 37·00
D	July 3	1 37·10	1 37·20
	Dec. 32	1 37·32	1 37·42
1875	Jan. 1	2 34·46	2 34·56
C	July 3	2 34·68	2 34·77
	Dec. 32	2 34·90	2 34·98
1876	Jan. 1	3 32·04	3 32·12
B	July 2	3 32·25	3 32·32
	Dec. 32	3 32·45	3 32·51
1877	Jan. 1	0 33·68	0 33·74
G	July 3	0 33·86	0 33·90
	Dec. 32	0 34·02	0 34·04
1878	Jan. 1	1 31·16	1 31·18
F	July 3	1 31·29	1 31·29
	Dec. 32	1 31·39	1 31·38
1879	Jan. 1	2 28·53	2 28·51
E	July 3	2 28·59	2 28·56
	Dec. 32	2 28·62	2 28·57
1880	Jan. 1	3 25·76	3 25·71
D	July 2	3 25·75	3 25·68
	Dec. 32	3 25·70	3 25·62

		9h R.A. sec	10h R.A. sec
Jan.	1	11·47	11·16
	11	11·74	11·48
	21	11·95	11·75
	31	12·10	11·97
Feb.	10	12·19	12·13
	20	12·21	12·23
Mar.	2	12·17	12·27
	12	12·08	12·25
	22	11·95	12·18
Apr.	1	11·79	12·06
	11	11·60	11 92
	21	11·41	11·75
May	1	11·21	11·58
	11	11·03	11·40
	21	10·87	11·22
	31	10·73	11·07
June	10	10·63	10·93
	20	10·55	10·81
	30	10·52	10·72
July	10	10·52	10·66
	20	10·56	10·63
	30	10·64	10·63
Aug.	9	10·75	10·67
	19	10·90	10·74
	29	11·08	10·85
Sept.	8	11·30	10·99
	18	11·56	11·18
	28	11·84	11·39
Oct.	8	12·16	11·65
	18	12·50	11·95
	28	12·87	12·27
Nov.	7	13·25	12·63
	17	13·65	13·01
	27	14·04	13·41
Dec.	7	14·43	13·81
	17	14·80	14·20
	27	15·14	14·58
	37	15·43	14·92

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Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME			North Polar Dist.			Variation	
		Right Ascension		Variation					
		h m s		Annual sec. +	Secular sec. −	° ′ ″		Annual + ″	Secular + ″
Ra 2456 WB	6·1	10 1	44·10	3·568	·037	51 56	55·3	17·53	·27
WB 197 L β	8·	10 8	56·44	3·545	·031	51 49	58·0	17·82	·23
3Gr 806 BAC = LeMi	4·5	10 18	32·95	3·482	·030	52 37	2·3	18·29	·21
Rad 2503 G	5·7	10 20	41·79	3·519	·037	50 24	1·0	18·30	·23
R 2505 G	7·4	10 21	38·04	3·513	·037	50 18	7·8	18·30	·21
3 G 825 Rad	6·	10 29	50·77	3·443	·031	51 24	9·5	18·62	·18
WB 894–5 L	7·8	10 43	20·75	3·410	·031	50 57	46·3	19·00	·15
Ra 2614 *	7·9	10 54	42·58	3·363	·034	50 19	42·3	19·29	·13
R 2615 WB	7·2	10 55	8·47	3·360	·034	50 25	15·1	19·30	·13
Ra 2616 WB	6·1	10 55	22·95	3·353	·031	51 2	53·9	19·31	·14
Ra 2617 WB	7·6	10 55	35·69	3·352	·031	51 2	34·0	19·31	·13

*Ra 2614 RA. by G 10 54 43·20

Year and Dominical Letter		10h R.A. m	sec	11h R.A. m	sec
1868	Jan. 1	3	45·62	3	45·61
E	July 2	3	45·46	3	45·47
	Dec. 32	3	45·34	3	45·36
1869	Jan. 1	0	46·57	0	46·59
C	July 3	0	46·48	0	46·51
	Dec. 32	0	46·42	0	46·48
1870	Jan. 1	1	43·56	1	43·61
B	July 3	1	43·54	1	43·61
	Dec. 32	1	43·56	1	43·64
1871	Jan. 1	2	40·70	2	40·78
A	July 3	2	40·76	2	40·85
	Dec. 32	2	40·85	2	40·95
1872	Jan. 1	3	37·99	3	38·08
G	July 2	3	38·11	3	38·21
	Dec. 32	3	38·26	3	38·36
1873	Jan. 1	0	39·49	0	39·59
E	July 3	0	39·67	0	39·77
	Dec. 32	0	39·86	0	39·96
1874	Jan. 1	1	37·00	1	37·09
D	July 3	1	37·20	1	37·29
	Dec. 32	1	37·42	1	37·50
1875	Jan. 1	2	34·56	2	34·64
C	July 3	2	34·77	2	34·84
	Dec. 32	2	34·98	2	35·04
1876	Jan. 1	3	32·12	3	32·17
B	July 2	3	32·32	3	32·36
	Dec. 32	3	32·51	3	32·53
1877	Jan. 1	0	33·74	0	33·76
G	July 3	0	33·90	0	33·91
	Dec. 32	0	34·04	0	34·03
1878	Jan. 1	1	31·18	1	31·17
F	July 3	1	31·29	1	31·27
	Dec. 32	1	31·38	1	31·33
1879	Jan. 1	2	28·51	2	28·47
E	July 3	2	28·56	2	28·50
	Dec. 32	2	28·57	2	28·50
1880	Jan. 1	3	25·71	3	25·64
D	July 2	3	25·68	3	25·60
	Dec. 32	3	25·62	3	25·53

	10h R.A. sec	11h R.A. sec
Jan. 1	11·16	10·77
11	11·48	11·13
21	11·75	11·46
31	11·97	11·74
Feb. 10	12·13	11·97
20	12·23	12·14
Mar. 2	12·27	12·25
12	12·25	12·30
22	12·18	12·30
April 1	12·06	12·25
11	11·92	12·16
21	11·75	12·04
May 1	11·58	11·90
11	11·40	11·74
21	11·22	11·57
31	11·07	11·41
June 10	10·93	11·25
20	10·81	11·11
30	10·72	10·98
July 10	10·66	10·87
20	10·63	10·78
30	10·63	10·71
Aug. 9	10·67	10·68
19	10·74	10·67
29	10·85	10·70
Sept. 8	10·99	10·76
18	11·18	10·86
28	11·39	11·01
Oct. 8	11·65	11·19
18	11·95	11·42
28	12·27	11·69
Nov. 7	12·63	12·01
17	13·01	12·35
27	13·41	12·73
Dec. 7	13·81	13·12
17	14·20	13·52
27	14·58	13·92
37	14·92	14·30

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec. −	°	′	″	Annual + ″	Secular + ″
BAC 3811 WB	6·	11	0	15·24	3·322	·029	52	58	28·4	19·44	·12
Ra 2643 WB	7·7	11	5	59·17	3·299	·029	51	42	8·4	19·53	·09
3 Gr 883 Rad	5·	11	10	5·69	3·283	·028	51	5	27·1	19·71	·09
Ra 2675 WB	6·9	11	14	54·19	3·256	·029	52	2	25·2	19·70	·09
R 2685 G	7·3	11	18	47·16	3·243	·029	51	19	54·4	19·74	·05
Ra 2696	7·1	11	21	17·96	3·232	·028	51	19	5·1	19·80	·08
WB 596–7 L	8·	11	29	49·97	3·198	·027	50	37	9·6	19·90	·05
3 Gree 934 Radc	6·7	11	43	26·24	3·475	·024	51	20	3·1	25·71	·02
3 Gre 941 WB	8·	11	50	0·23	3·101	·023	51	23	20·6	20·04	·01

Year and Dominical Letter		11h R.A. m sec	12h R.A. m sec
1868	Jan. 1	3 45·61	3 45·63
E	July 2	3 45·47	3 45·51
	Dec. 32	3 45·36	3 45·41
1869	Jan. 1	0 46·59	0 46·64
C	July 3	0 46·51	0 46·58
	Dec. 32	0 46·48	0 46·55
1870	Jan. 1	1 43·61	1 43·69
B	July 3	1 43·61	1 43·69
	Dec. 32	1 43·64	1 43·73
1871	Jan. 1	2 40·78	2 40·87
A	July 3	2 40·85	2 40·94
	Dec. 32	2 40·95	2 41·04
1872	Jan. 1	3 38·08	3 38·18
G	July 2	3 38·21	3 38·31
	Dec. 32	3 38·36	3 38·46
1873	Jan. 1	0 39·59	0 39·68
E	July 3	0 39·77	0 39·85
	Dec. 32	0 39·96	0 40·03
1874	Jan. 1	1 37·09	1 37·17
D	July 3	1 37·29	1 37·36
	Dec. 32	1 37·50	1 37·55
1875	Jan. 1	2 34·64	2 34·69
C	July 3	2 34·84	2 34·88
	Dec. 32	2 35·04	2 35·06
1876	Jan. 1	3 32·17	3 32·20
B	July 2	3 32·36	3 32·37
	Dec. 32	3 32·53	3 32·52
1877	Jan. 1	0 33·76	0 33·75
G	July 3	0 33·91	0 33·88
	Dec. 32	0 34·03	0 33·99
1878	Jan. 1	1 31·17	1 31·13
F	July 3	1 31·27	1 31·21
	Dec. 32	1 31·33	1 31·27
1879	Jan. 1	2 28·47	2 28·40
E	July 3	2 28·50	2 28·42
	Dec. 32	2 28·50	2 28·41
1880	Jan. 1	3 25·64	3 25·55
D	July 2	3 25·60	3 25·51
	Dec. 32	3 25·53	3 25·43

		11h R.A. sec	12h R.A. sec
Jan.	1	10·77	10·33
	11	11·13	10·72
	21	11·46	11·08
	31	11·74	11·41
Feb.	10	11·97	11·69
	20	12·14	11·93
Mar.	2	12·25	12·11
	12	12·30	12·24
	22	12·30	12·31
April	1	12·25	12·33
	11	12·16	12·31
	21	12·04	12·25
May	1	11·90	12·15
	11	11·74	12·03
	21	11·57	11·89
	31	11·41	11·74
June	10	11·25	11·59
	20	11·11	11·43
	30	10·98	11·28
July	10	10·87	11·13
	20	10·78	10·99
	30	10·71	10·87
Aug.	9	10·68	10·77
	19	10·67	10·69
	29	10·70	10·64
Sept.	8	10·76	10·62
	18	10·86	10·64
	28	11·01	10·70
Oct.	8	11·19	10·81
	18	11·42	10·96
	28	11·69	11·17
Nov.	7	12·01	11·42
	17	12·35	11·71
	27	12·73	12·05
Dec.	7	13·12	12·41
	17	13·51	12·80
	27	13·92	13·20
	37	14·30	13·59

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MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec. −	°	′	″	Annual + ″	Secular − ″
Ra 2801	7·4	12	0	48·08	3·047	·026	50	37	50·0	20·05	0
R 2806 G	7·6	12	2	30·43	3·040	·023	50	8	10·2	20·05	0
2 G 799 R	7·	12	11	38·58	2·999	·022	51	21	52·8	20·02	·02
R 2843 G	7·8	12	12	29·29	2·993	·023	51	14	35·5	20·01	·04
1 G 1009 Rad	5·6	12	17	19·52	2·964	·022	50	14	56·4	20·07	·03
Ra 2880 G	6·4	12	25	1·31	2·935	·020	51	12	6·4	19·92	·05
Ra 2909 B.A.C.	6·	12	36	40·15	2·840	·020	50	0	11·7	19·60	·09
1 G 1028 Ra	6·	12	41	49·10	2·861	·018	51	45	51·6	19·68	·08
3 Gre 1018 R	7·	12	47	43·63	2·810	·015	50	58	19·0	19·54	·10
3Gre1019R=CaVeα	3·	12	47	44·84	2·808	·015	50	58	5·3	19·52	·10

Year and Dominical Letter		12h R.A. m sec	13h R.A. m sec
1868	Jan. 1	3 45·63	3 45·68
E	July 2	3 45·51	3 45·57
	Dec. 32	3 45·41	3 45·49
1869	Jan. 1	0 46·64	0 46·72
C	July 3	0 46·58	0 46·66
	Dec. 32	0 46·55	0 46·64
1870	Jan. 1	1 43·69	1 43·78
B	July 3	1 43·69	1 43·79
	Dec. 32	1 43·73	1 43·83
1871	Jan. 1	2 40·87	2 40·97
A	July 3	2 40·94	2 41·04
	Dec. 32	2 41·04	2 41·13
1872	Jan. 1	3 38·18	3 38·27
G	July 2	3 38·31	3 38·39
	Dec. 32	3 38·46	3 38·53
1873	Jan. 1	0 39·68	0 39·76
E	July 3	0 39·85	0 39·91
	Dec. 32	0 40·03	0 40·08
1874	Jan. 1	1 37·17	1 37·22
D	July 3	1 37·36	1 37·39
	Dec. 32	1 37·55	1 37·57
1875	Jan. 1	2 34·69	2 34·71
C	July 3	2 34·88	2 34·88
	Dec. 32	2 35·06	2 35·05
1876	Jan. 1	3 32·20	3 32·18
B	July 2	3 32·37	3 32·34
	Dec. 32	3 32·52	3 32·48
1877	Jan. 1	0 33·75	0 33·71
G	July 3	0 33·88	0 33·83
	Dec. 32	0 33·99	0 33·93
1878	Jan. 1	1 31·13	1 31·06
F	July 3	1 31·21	1 31·14
	Dec. 32	1 31·27	1 31·18
1879	Jan. 1	2 28·40	2 28·32
E	July 3	2 28·42	2 28·33
	Dec. 32	2 28·41	2 28·32
1880	Jan. 1	3 25·55	3 25·46
D	July 2	3 25·51	3 25·41
	Dec. 32	3 25·43	3 25·34

		12h R.A. sec	13h R.A. sec
Jan.	1	10·33	9·88
	11	10·72	10·27
	21	11·08	10·65
	31	11·41	11·01
Feb.	10	11·69	11·34
	20	11·93	11·62
Mar.	2	12·11	11·87
	12	12·24	12·07
	22	12·31	12·21
Apr.	1	12·33	12·31
	11	12·31	12·35
	21	12·25	12·36
May	1	12·15	12·32
	11	12·03	12·26
	21	11·89	12·16
	31	11·74	12·04
June	10	11·59	11·90
	20	11·43	11·75
	30	11·28	11·59
July	10	11·13	11·43
	20	10·99	11·26
	30	10·87	11·10
Aug.	9	10·77	10·94
	19	10·69	10·80
	29	10·64	10·68
Sept.	8	10·62	10·59
	18	10·64	10·53
	28	10·70	10·51
Oct.	8	10·81	10·53
	18	10·96	10·60
	28	11·17	10·73
Nov.	7	11·42	10·91
	17	11·71	11·14
	27	12·05	11·41
Dec.	7	12·41	11·74
	17	12·80	12·09
	27	13·20	12·47
	37	13·59	12·86

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MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec. −	°	′	″	Annual + ″	Secular − ″
1 G 1051 R	6·	13	1	25·28	2·775	·015	51	52	21·8	19·28	·11
R 2969 BAC	5·9	13	1	29·05	2·762	·017	50	45	42·9	19·28	·12
R 2970 G	7·1	13	1	48·99	2·759	·017	50	34	20·0	19·27	·13
R 2971 G	5·9	13	1	50·96	2·761	·017	50	47	55·9	19·27	·13
R 2999 G	7·2	13	13	1·22	2·719	·014	51	27	0·8	18·97	·15
Ra 3007 WB	6·4	13	15	44·07	2·717	·014	52	16	31·7	18·90	·14
R 3048 G	6·9	13	26	19·23	2·647	·014	50	32	3·5	18·57	·16
3 G 1085 Ra	5·	13	26	41·67	2·683	·009	52	8	27·0	18·65	·15
Ra 3060 Σ	7·8	13	30	4·84	2·624	·014	50	8	34·7	18·44	·17
R 3090 G	6·3	13	38	21·63	2·600	·011	50	50	2·0	18·15	·17
R 3092 G	6·	13	39	3·78	2·596	·011	50	47	45·2	18·13	·16
WB 929–30 L	7·	13	41	45·03	2·618	·007	52	42	35·4	18·02	·17
WB 976–7	8·	13	43	29·85	2·594	·007	51	37	36·1	17·95	·17
WB 1281–2	8·	13	56	17·07	2·548	·006	51	59	37·3	17·43	·19

Year and Dominical Letter		13h R.A. m sec	14h R.A. m sec
1868	Jan. 1	3 45.68	3 45.76
E	July 2	3 45.57	3 45.66
	Dec. 32	3 45.49	3 45.59
1869	Jan. 1	0 46.72	0 46.81
C	July 3	0 46.66	0 46.76
	Dec. 32	0 46.64	0 46.75
1870	Jan. 1	1 43.78	1 43.88
B	July 3	1 43.79	1 43.89
	Dec. 32	1 43.83	1 43.93
1871	Jan. 1	2 40.97	2 41.06
A	July 3	2 41.04	2 41.12
	Dec. 32	2 41.13	2 41.21
1872	Jan. 1	3 38.27	3 38.35
G	July 2	3 38.39	3 38.46
	Dec. 32	3 38.53	3 38.58
1873	Jan. 1	0 39.76	0 39.81
E	July 3	0 39.91	0 39.95
	Dec. 32	0 40.08	0 40.10
1874	Jan. 1	1 37.22	1 37.24
D	July 3	1 37.39	1 37.40
	Dec. 32	1 37.57	1 37.56
1875	Jan. 1	2 34.71	2 34.70
C	July 3	2 34.88	2 34.85
	Dec. 32	2 35.05	2 35.00
1876	Jan. 1	3 32.18	3 32.14
B	July 2	3 32.34	3 32.28
	Dec. 32	3 32.48	3 32.41
1877	Jan. 1	0 33.71	0 33.64
G	July 3	0 33.83	0 33.75
	Dec. 32	0 33 93	0 33.84
1878	Jan. 1	1 31.06	1 30.97
F	July 3	1 31.14	1 31.04
	Dec. 32	1 31.18	1 31.08
1879	Jan. 1	2 28.32	2 28.22
E	July 3	2 28.33	2 28.23
	Dec. 32	2 28.32	2 28.22
1880	Jan. 1	3 25.46	3 25.36
D	July 2	3 25.41	3 25.32
	Dec. 32	3 25.34	3 25.26

	13h R.A. sec	14h R.A. sec
Jan. 1	9.88	9.43
11	10.27	9.80
21	10.65	10.18
31	11.01	10.56
Feb. 10	11.34	10.91
20	11.62	11.24
Mar. 2	11.87	11.54
12	12.07	11.80
22	12.21	12.01
Apr. 1	12.31	12.17
11	12.35	12.29
21	12.36	12.37
May 1	12.32	12.40
11	12.26	12.40
21	12.16	12.36
31	12.04	12.28
June 10	11.90	12.18
20	11.75	12.05
30	11.59	11.90
July 10	11.43	11.74
20	11.26	11.56
30	11.10	11.37
Aug. 9	10.94	11.18
19	10.80	11.00
29	10.68	10.82
Sept. 8	10.59	10.66
18	10.53	10.53
28	10.51	10.43
Oct. 8	10.53	10.38
18	10.60	10.37
28	10.73	10.41
Nov. 7	10.91	10.51
17	11.14	10.66
27	11.41	10.87
Dec. 7	11.74	11.13
17	12.09	11.44
27	12.47	11.78
37	12.86	12.14

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MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME				North Polar Dist.			Variation	
		Right Ascension			Variation					
		h	m	s	Annual sec. +	Secular sec. −	°	′	″	Annual + ″	Secular − ″
WB 77–8	8·	14	2	38·53	2·511	·005	51	22	36·3	17·14	·20
Ra 3183 G	7·1	14	11	10·47	2·459	·009	50	37	27·5	16·74	·21
Ra 3187 G	6·8	14	12	2·55	2·455	·009	50	35	52·5	16·70	·21
Ra 3196 G	7·4	14	15	40·38	2·476	·006	52	11	40·1	16·53	·20
Ra 3201 G	6·2	14	17	45·10	2·443	·006	51	0	34·3	16·42	·21
2G903Rad=Bootis γ	3·	14	24	23·88	2·421	·005	51	6	47·6	15·94	·21
Ra 3219 G	6·3	14	25	34·54	2·445	·006	52	27	22·6	16·02	·22
BAC 4825 L	6·	14	26	52·84	2·459	·005	52	47	32·0	16·00	·22
Ra 3242 G	7·6	14	32	19·61	2·395	·003	51	19	16·5	15·64	·24
R 3244 G	7·4	14	33	19·55	2·390	·006	51	17	24·6	15·59	·23
Ra 3265 WB	6·2	14	41	31·50	2·370	·003	51	38	38·9	15·13	·24
Ra 3269 WB	6·	14	42	52·41	2·379	·003	52	11	4·6	15·05	·25
R 3276 G	7·5	14	44	4·62	2·327	·006	50	21	6·6	14·98	·24
3 G 1190 Ra	5·	14	52	6·78	2·295	·000	50	12	35·4	14·48	·24

Year and Dominical Letter		14h R.A. m sec	15h R.A. m sec
1868	Jan. 1	3 45·76	3 45·86
E	July 2	3 45·66	3 45·77
	Dec. 32	3 45·59	3 45·69
1869	Jan. 1	0 46·81	0 46·92
C	July 3	0 46·76	0 46·87
	Dec. 32	0 46·75	0 46·85
1870	Jan. 1	1 43·88	1 43·99
B	July 3	1 43·89	1 43·99
	Dec. 32	1 43·93	1 44·01
1871	Jan. 1	2 41·06	2 41·15
A	July 3	2 41·12	2 41·20
	Dec. 32	2 41·21	2 41·27
1872	Jan. 1	3 38·35	3 38·41
G	July 2	3 38·46	3 38·50
	Dec. 32	3 38·58	3 38·61
1873	Jan. 1	0 39·81	0 39·84
E	July 3	0 39·95	0 39·96
	Dec. 32	0 40·10	0 40·09
1874	Jan. 1	1 37·24	1 37·23
D	July 3	1 37·40	1 37·37
	Dec. 32	1 37·56	1 37·51
1875	Jan. 1	2 34·70	2 34·65
C	July 3	2 34·85	2 34·79
	Dec. 32	2 35·00	2 34·93
1876	Jan. 1	3 32·14	3 32·07
B	July 2	3 32·28	3 32·20
	Dec. 32	3 32·41	3 32·31
1877	Jan. 1	0 33·64	0 33·54
G	July 3	0 33·75	0 33·64
	Dec. 32	0 33·84	0 33·73
1878	Jan. 1	1 30·97	1 30·87
F	July 3	1 31·04	1 30·93
	Dec. 32	1 31·08	1 30·97
1879	Jan. 1	2 28·22	2 28·11
E	July 3	2 28·23	2 28·13
	Dec. 32	2 28·22	2 28·13
1880	Jan. 1	3 25·36	3 25·26
D	July 2	3 25·32	3 25·23
	Dec. 32	3 25·26	3 25·18

	14h R A. sec	15h R.A. sec
Jan. 1	9·43	9·03
11	9·80	9·37
21	10·18	9·73
31	10·56	10·10
Feb. 10	10·91	10·46
20	11·24	10·81
Mar. 2	11·54	11·14
12	11·80	11·44
22	12·01	11·71
April 1	12·17	11·94
11	12·29	12·13
21	12·37	12·27
May 1	12·40	12·38
11	12·40	12·44
21	12·36	12·47
31	12·28	12·45
June 10	12·18	12·40
20	12·05	12·31
30	11·90	12·19
July 10	11·74	12·05
20	11·56	11·87
30	11·37	11·68
Aug. 1	11·18	11·48
19	11·00	11·26
29	10·82	11·05
Sept. 8	10·66	10·84
18	10·53	10·65
28	10·43	10·48
Oct. 8	10·38	10·35
18	10·37	10·26
28	10·41	10·23
Nov. 7	10·51	10·24
17	10·66	10·32
27	10·87	10·45
Dec. 7	11·13	10·64
17	11·44	10·89
27	11·78	11·18
37	12·14	11·50

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec.	°	′	″	Annual + ″	Secular − ″
1 G 1226 L	7·½	15	4	23·86	2·324		52	44	53·5	13·73	·25
Rad 3336 G	6·2	15	6	5·21	2·276		51	14	21·2	13·64	·24
R 3346 G	6·9	15	7	27·09	2·271		51	12	36·9	13·55	·25
2 Gree 972 Σ=Boo μ	4·3	15	16	59·61	2·261		52	9	30·7	12·84	·25
2 Gr973 R Σ Bootis μ 2	8·	15	17	1·02	2·261		52	11	19·0	12·92	·25
1 G 1259 Ra	6·7	15	21	5·49	2·219		50	49	7·4	12·63	·25
3G1240R = CorBor μ	5·	15	27	51·94	2·193		50	33	0·6	12·16	·26
3G1244–5 Σ CorBor ζ	4·	15	31	51·14	2·253		52	56	1·8	11·99	·27
WB 862–3	7·	15	32	58·21	2·224		52	3	22·2	11·82	·27
WB 892–3	7·8	15	34	2·57	2·189		51	1	3·6	11·74	·26
Ra 3472G=CorBorλ	5·1	15	48	23·75	2·174		51	40	12·0	10·62	·29
Ra 3482	6·7	15	53	37·24	2·117		50	27	4·5	10·31	·26

Year and Dominical Letter		15h R.A. m sec	16h R.A. m. sec
1868	Jan. 1	3 45·86	3 45·98
E	July 2	3 45·77	3 45·89
	Dec. 32	3 45·69	3 45·81
1869	Jan. 1	0 46·92	0 47·04
C	July 3	0 46·87	0 46·98
	Dec. 32	0 46·85	0 46·95
1870	Jan. 1	1 43·99	1 44·09
B	July 3	1 43·99	1 44·08
	Dec. 32	1 44·01	1 44·09
1871	Jan. 1	2 41·15	2 41·22
A	July 3	2 41·20	2 41·26
	Dec. 32	2 41·27	2 41·31
1872	Jan. 1	3 38·41	3 38·45
G	July 2	3 38·50	3 38·52
	Dec. 32	3 38·61	3 38·61
1873	Jan. 1	0 39·84	0 39·84
E	July 3	0 39·96	0 39·94
	Dec. 32	0 40·09	0 40·06
1874	Jan. 1	1 37·23	1 37·19
D	July 3	1 37·37	1 37·32
	Dec. 32	1 37·51	1 37·44
1875	Jan. 1	2 34·65	2 34·58
C	July 3	2 34·79	2 34·71
	Dec. 32	2 34·96	2 34·83
1876	Jan. 1	3 32·07	3 31·97
B	July 2	3 32·20	3 32·09
	Dec. 32	3 32·31	3 32·20
1877	Jan. 1	0 33·54	0 33·43
G	July 3	0 33·64	0 33·53
	Dec. 32	0 33·73	0 33·61
1878	Jan. 1	1 30·87	1 30·75
F	July 3	1 30·93	1 30·82
	Dec. 32	1 30·97	1 30·87
1879	Jan. 1	2 28·11	2 28·01
E	July 3	2 28·13	2 28·03
	Dec. 32	2 28·13	2 28·04
1870	Jan. 1	3 25·26	3 25·18
D	July 2	3 25·23	3 25·16
	Dec. 32	3 25·18	3 25·13

	15h R.A. sec	16h R.A. sec
Jan. 1	9·03	8·69
11	9·37	8·98
21	9·73	9·31
31	10·10	9·65
Feb. 10	10·46	10·00
20	10·81	10·36
Mar. 2	11·14	10·71
12	11·44	11·04
22	11·71	11·35
Apr. 1	11·94	11·63
11	12·13	11·88
21	12·27	12·09
May 1	12·38	12·26
11	12·44	12·40
21	12·47	12·49
31	12·45	12·54
June 10	12·40	12·55
20	12·31	12·51
30	12·19	12·44
July 10	12·05	12·33
20	11·87	12·18
30	11·68	12·00
Aug. 9	11·48	11·80
19	11·26	11·58
29	11·05	11·34
Sept. 8	10·84	11·10
18	10·65	10·87
28	10·48	10·65
Oct. 8	10·35	10·46
18	10·26	10·31
28	10·23	10·20
Nov. 7	10·24	10·14
17	10·32	10·13
27	10·45	10·19
Dec 7	10·64	10·31
17	10·89	10·48
27	11·18	10·70
37	11·50	10·97

TABLE I.

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Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec. +	°	′	″	Annual + ″	Secular − ″
R 3516 WB :	6·4	16	4	49·88	2·097	·003	50	36	12·3	9·45	·27
R 3520 G	7.	16	5	52·40	2·128	·003	51	35	30·1	9·37	·28
3 G 1329 BAC	6·5	16	18	1·41	2·129	·003	52	18	13·9	8·41	·29
R 3546 WB	7·7	16	18	5·27	2·109	·002	51	47	13·0	8·42	·26
Ra 3574 G	6·8	16	26	23·27	2·088	·002	51	38	6·6	7·74	·30
Ra 3585 G	6·9	16	30	52·77	2·027	·003	50	9	22·5	7·38	·27
1G 1396 Radc=Her η	3·	16	35	38·72	2·049	·001	50	49	29·8	7·04	·28
WB 1457–8	8·	16	44	17·32	2·048	·004	51	15	35·0	6·28	·29
Ra 3637 G	7·1	16	52	52·70	2·012	·000	50	42	27·7	5·55	·29

Year and Dominical Letter		16h R.A. m sec	17h R.A. m sec
1868	Jan. 1	3 45·98	3 46·10
E	July 2	3 45·89	3 46·01
	Dec. 32	3 45·81	3 45·92
1869	Jan. 1	0 47·04	0 47·15
C	July 3	0 46·98	0 47·09
	Dec. 32	0 46·95	0 47·04
1870	Jan. 1	1 44·09	1 44·18
B	July 3	1 44·08	1 44·15
	Dec. 32	1 44·09	1 44·14
1871	Jan. 1	2 41·22	2 41·28
A	July 3	2 41·26	2 41·29
	Dec. 32	2 41·31	2 41·33
1872	Jan. 1	3 38·45	3 38·46
G	July 2	3 38·52	3 38·52
	Dec. 32	3 38·61	3 38·59
1873	Jan. 1	0 39·84	0 39·81
E	July 3	0 39·94	0 39·90
	Dec. 32	0 40·06	0 39·99
1874	Jan. 1	1 37·19	1 37·13
D	July 3	1 37·32	1 37·23
	Dec. 32	1 37·44	1 37·35
1875	Jan. 1	2 34·58	2 34·49
C	July 3	2 34·71	2 34·60
	Dec. 32	2 34·83	2 34·72
1876	Jan. 1	3 31·97	3 31·85
B	July 2	3 32·09	3 31·97
	Dec. 32	3 32·20	3 32·08
1877	Jan. 1	0 33·43	0 33·31
G	July 3	0 33·53	0 33·41
	Dec. 32	0 33·61	0 33·50
1878	Jan. 1	1 30·75	1 30·63
F	July 3	1 30·82	1 30·71
	Dec. 32	1 30·87	1 30·77
1879	Jan. 1	2 28·01	2 27·91
E	July 3	2 28·03	2 27·95
	Dec. 32	2 28·04	2 27·97
1880	Jan. 1	3 25·18	3 25·11
D	July 2	3 25·16	3 25·11
	Dec. 32	3 25·13	3 25·10

		16h R.A. sec	17h R.A. sec
Jan.	1	8·69	8·45
	11	8·98	8·68
	21	9·31	8·95
	31	9·65	9·25
Feb.	10	10·00	9·57
	20	10·36	9·91
Mar.	2	10·71	10·26
	12	11·04	10·60
	22	11·35	10·94
Apr.	1	11·63	11·26
	11	11·88	11·55
	21	12·09	11·82
May	1	12·26	12·05
	11	12·40	12·25
	21	12·49	12·41
	31	12·54	12·53
June	10	12·55	12·61
	20	12·51	12·64
	30	12·44	12·62
July	10	12·33	12·56
	20	12·18	12·46
	30	12·00	12·31
Aug.	9	11·80	12·13
	19	11·58	11·92
	29	11·34	11·69
Sept.	8	11·10	11·44
	18	10·87	11·18
	28	10·65	10·94
Oct.	8	10·46	10·70
	18	10·31	10·49
	28	10·20	10·32
Nov.	7	10·14	10·20
	17	10·13	10·12
	27	10·19	10·10
Dec.	7	10·31	10·14
	17	10·48	10·24
	27	10·70	10·39
	37	10·97	10·59

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Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec. +	°	′	″	Annual + ″	Secular − ″
R 3682 G	6·9	17	6	12·79	2·003	·000	50	51	32·8	4·42	·29
3 G 1402 BAC	5·	17	10	17·92	2·064	·003	52	34	6·7	3·96	·30
Ra 3693 G	6·	17	11	8·04	2·006	·003	51	3	8·2	4·00	·29
2 Gr 1123–4 Σ=Her ρ	4·	17	16	17·50	2·067	·001	52	43	50·6	3·53	·30
Ra 3705 G	6·8	17	16	45·50	2·012	·006	51	17	49·5	3·50	·31
R 3707 WB	7·1	17	17	25·21	1·986	·001	50	40	15·1	3·45	·28
Rad 3717 G	6·6	17	23	24·29	1·995	·003	51	1	3·7	2·94	·29
Ra 3758 G	6·5	17	38	36·11	1·989	·003	51	3	53·8	1·61	·30
Ra 3759 G	6·7	17	38	43·02	1·971	·003	50	37	32·8	1·60	·30
2 G 1161 Σ=Herc θ	4·	17	48	47·98	2·049	·000	52	43	49·4	0·67	·30
Ra 3839	7·9	17	58	29·96	1·983	·000	51	0	46·8	0·13	·29

Year and Dominical Letter		17h R.A. m sec	18h R.A. m sec
1868	Jan. 1	3 46.10	3 46·23
E	July 2	3 46·01	3 46·12
	Dec. 32	3 45·92	3 46·03
1869	Jan. 1	0 47·15	0 47·26
C	July 3	0 47·09	0 47·18
	Dec. 32	0 47·04	0 47·11
1870	Jan. 1	1 44·18	1 44·25
B	July 3	1 44·15	1 44·20
	Dec. 32	1 44·14	1 44·18
1871	Jan. 1	2 41·28	2 41·31
A	July 3	2 41·29	2 41·31
	Dec. 32	2 41·33	2 41·32
1872	Jan. 1	3 38·46	3 38·45
G	July 2	3 38·52	3 38·49
	Dec. 32	3 38·59	3 38·53
1873	Jan. 1	0 39·81	0 39·76
E	July 3	0 39·90	0 39·83
	Dec. 32	0 39·99	0 39·91
1874	Jan. 1	1 37·13	1 37·04
D	July 3	1 37·23	1 37·13
	Dec. 32	1 37·35	1 37·24
1875	Jan. 1	2 34·49	2 34·37
C	July 3	2 34·60	2 34·48
	Dec. 32	2 34·72	2 34·59
1876	Jan. 1	3 31·85	3 31·73
B	July 2	3 31·97	3 31·84
	Dec. 32	3 32·08	3 31·95
1877	Jan. 1	0 33·31	0 33·18
G	July 3	0 33·41	0 33·29
	Dec. 32	0 33 50	0 33·39
1878	Jan. 1	1 30·63	1 30·52
F	July 3	1 30·71	1 30·61
	Dec. 32	1 30·77	1 30·69
1879	Jan. 1	2 27·91	2 27·82
E	July 3	2 27·95	2 27·88
	Dec. 32	2 27·97	2 27·93
1880	Jan. 1	3 25·11	3 25·06
D	July 2	3 25·11	3 25·09
	Dec. 32	3 25·10	3 25·09

		17h R.A. sec	18h R.A. sec
Jan.	1	8·45	8·32
	11	8·68	8·47
	21	8·95	8·68
	31	9·25	8·93
Feb.	10	9·57	9·20
	20	9·91	9·51
Mar.	2	10·26	9·83
	12	10·60	10·17
	22	10·94	10·51
Apr.	1	11·26	10·85
	11	11·55	11·17
	21	11·82	11·48
May	1	12·05	11·77
	11	12·25	12·03
	21	12·41	12·26
	31	12·53	12·44
June	10	12·61	12·58
	20	12·64	12·69
	30	12·62	12·74
July	10	12·56	12·74
	20	12·46	12·69
	30	12·31	12·59
Aug.	9	12·13	12·45
	19	11·92	12·27
	29	11·69	12·06
Sept.	8	11·44	11·82
	18	11·18	11·57
	28	10·94	11·31
Oct.	8	10·70	11·05
	18	10·49	10·81
	28	10·32	10·60
Nov.	7	10·20	10·42
	17	10·12	10·28
	27	10·10	10·19
Dec.	7	10·14	10·16
	17	10·24	10·18
	27	10·39	10·26
	37	10·59	10·39

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec.	°	′	″	Annual − ″	Secular − ″
Ra 3856 G	7·6	18	3	33·26	1·985		51	4	0·6	0·57	·28
Ra 3859 WB	7·1	18	3	52·49	1·980		50	55	43·1	0·60	·28
Ra 3867 G	6·3	18	5	42·30	1·993		51	15	42·4	0·76	·29
R 3913 G=Lyræ μ	5·1	18	16	52·68	1·967		50	33	46·7	1·74	·28
R 3959 WB	7·7	18	25	16·62	2·000		51	13	59·0	2·47	·28
Ra 3960 G	7·3	18	25	24·83	2·006		51	15	41·1	2·48	·27
1 G 1630 Ra	7·	18	27	54·23	1·994		51	12	41·0	2·65	·29
3 Greenw 1501 Vega	1·	18	29	25·91	2·025		51	20	15·9	3·11	·29
R 3999 G	6·2	18	30	42·49	1·974		50	26	48·2	2·95	·29
Ra 4006 G	6·6	18	32	41·24	2·038		51	45	13·6	3·12	·30
Ra 4031 G	6·5	18	35	49·30	1·992		50	49	51·3	3·39	·29
Ra 4036 G	6·4	18	36	33·96	2·021		51	36	2·9	3·45	·28
3 G 1504–5 Σ Lyræ ϵ_4	4·	18	36	54·57	1·982		50	27	57·9	3·53	·28
3 G 1506–7 Σ Lyræ ϵ_5	4·	18	36	56·87	1·985		50	31	26·2	3·55	·28
3 G 1509 Σ Lyræ ζ_1	4·5	18	37	10·11	2·059		52	31	53·1	3·55	·29
3G 1510 BAC Lyræ ζ_2	5·	18	37	11·93	2·060		52	32	30·4	3·57	·29
R 4047 G	7·5	18	37	38·30	2·029		51	49	9·9	3·54	·27
Ra 4083 G	7·6	18	42	4·52	2 030		51	43	25·8	3·93	·29
Ra 4093 WB	7·2	18	43	10·72	1·997		50	48	50·5	4·02	·27
Ra 4099 G	7·3	18	43	57·24	1·999		50	50	11·9	4·09	·28
Ra 4140 G	7·4	18	50	49·83	1·994		50	32	7·7	4·68	·28
Ra 4141	7·3	18	50	57·78	1·989		50	24	0·6	4·69	·28
Ra 4145 G	6·4	18	51	39·83	2·011		50	57	49·5	4·75	·28
R 4152 G	7·6	18	52	53·04	2·009		50	50	57·9	4·85	·27
R 4157 G	7·7	18	53	4·35	1·989		50	20	25·0	4·87	·28
R 4158 G	7·4	18	53	5·95	1·988		50	19	8·4	4·87	·27
Ra 4173 G	7·9	18	55	35·67	1·988		50	14	21·5	5·09	·29
R 4180 WB	7·7	18	56	32·22	1·983		50	4	42·9	5·16	·29

Year and Dominical Letter		18h R.A. m sec	19h R.A. m sec
1868	Jan. 1	3 46·23	3 46·34
E	July 2	3 46·12	3 46·23
	Dec. 32	3 46·03	3 46·12
1869	Jan. 1	0 47·26	0 47·34
C	July 3	0 47·18	0 47·25
	Dec. 32	0 47·11	0 47·16
1870	Jan. 1	1 44·25	1 44·30
B	July 3	1 44·20	1 44·23
	Dec. 32	1 44·18	1 44·19
1871	Jan. 1	2 41·31	2 41·32
A	July 3	2 41·31	2 41·29
	Dec. 32	2 41·32	2 41·28
1872	Jan. 1	3 38·45	3 38·42
G	July 2	3 38·49	3 38·43
	Dec. 32	3 38·53	3 38·46
1873	Jan. 1	0 39·76	0 39·69
E	July 3	0 39·83	0 39·74
	Dec. 32	0 39·91	0 39·80
1874	Jan. 1	1 37·04	1 36·94
D	July 3	1 37·13	1 37·02
	Dec. 32	1 37·24	1 37·11
1875	Jan. 1	2 34·37	2 34·25
C	July 3	2 34·48	2 34·36
	Dec. 32	2 34·59	2 34·47
1876	Jan. 1	3 31·73	3 31·60
B	July 2	3 31·84	3 31·72
	Dec. 32	3 31·95	3 31·84
1877	Jan. 1	0 33·18	0 33·06
G	July 3	0 33·29	0 33·18
	Dec. 32	0 33·39	0 33·29
1878	Jan. 1	1 30·52	1 30·43
F	July 3	1 30·62	1 30·53
	Dec. 32	1 30·69	1 30·62
1879	Jan. 1	2 27·82	2 27·76
E	July 3	2 27·88	2 27·84
	Dec. 32	2 27·93	2 27·90
1880	Jan. 1	3 25·06	3 25·04
D	July 2	3 25·09	3 25·08
	Dec. 32	3 25·09	3 25·11

	18h R.A. sec	19h R.A. sec
Jan. 1	8·32	8·30
11	8·47	8·38
21	8·68	8·52
31	8·93	8·70
Feb. 10	9·20	8·92
20	9·51	9·17
Mar. 2	9·83	9·46
12	10·17	9·78
22	10·51	10·09
April 1	10·85	10·43
11	11·17	10·77
21	11·48	11·10
May 1	11·77	11·43
11	12·03	11·73
21	12·26	12·02
31	12·44	12·26
June 10	12·58	12·48
20	12·69	12·65
30	12·74	12·77
July 10	12·74	12·84
20	12·69	12·85
30	12·59	12·82
Aug. 9	12·45	12·74
19	12·27	12·61
29	12·06	12·44
Sept. 8	11·82	12·23
18	11·57	12·00
28	11·31	11·75
Oct. 8	11·05	11·49
18	10·81	11·23
28	10·60	10·99
Nov. 7	10·42	10·78
17	10·28	10·60
27	10·19	10·45
Dec. 7	10·16	10·35
17	10·18	10·31
27	10·26	10·32
37	10·39	10·37

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Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec.	°	′	″	Annual − ″	Secular − ″
Ra 4202 G	7·3	19	0	10·73	2·034		51	16	45·9	5·47	·27
Ra 4203	7·	19	0	37·35	2·025		51	3	14·0	5·51	·28
Ra 4213 G	7·9	19	3	13·66	2·029		51	2	46·7	5·73	·29
3 Gr 1552 R Lyræ η	4·5	19	6	7·66	2·037		51	4	46·8	6·03	·28
3G1560 BAC Lyræ θ	4·5	19	8	38·47	2·071		52	6	1·0	6·12	·29
Ra 4284 G	6·7	19	12	50·36	2·016		50	19	10·9	6·53	·27
Ra 4306 G	7·1	19	16	29·05	2·048		51	2	37·7	6·84	·29
Ra 4322	7·4	19	19	5·46	2·025		50	18	11·0	7·05	·27
Ra 4331 G	6·9	19	20	58·79	2·029		50	19	46·2	7·21	·29
Ra 4361 WB	6·6	19	25	49·00	2·081		51	31	26·9	7·60	·28
R 4390 G	6·6	19	29	6·14	2·100		51	54	38·8	7·85	·26
R 4394 G	6·7	19	29	27·89	2·094		51	42	6·3	7·88	·26
Ra 4414 WB	7·4	19	33	31·29	2·106		51	50	58·8	8·22	·28
Ra 4418 G	6·8	19	33	54·68	2·052		50	17	13·7	8·24	·26
Ra 4420 G	6·4	19	34	13·85	2·044		50	3	24·6	8·28	·27
R 4429	6·5	19	35	18·98	2·102		51	38	28·1	8·35	·26
Ra 4431 G	7·	19	35	18·93	2·056		50	18	59·0	8·37	·28
Ra 4434 WB	7·1	19	35	57·10	2·067		50	34	25·3	8·42	·27
3 G 1599 BAC +	5·6	19	36	17·80	2·161		52	57	47·7	8·53	·28
R 4450 G	7·2	19	38	7·96	2·066		50	25	55·5	8·59	·27
Ra 4457 G	7·	19	40	54·70	2·071		50	24	48·2	8·81	·27
Rad 4462 G	6·3	19	41	33·15	2·117		51	37	13·8	8·86	·28
Ra 4468 G +	5·2	19	42	39·00	2·116		51	36	55·5	9·07	·29
R 4475 G	7·8	19	43	44·30	2·091		50	48	5·9	9·02	·26
Ra 4485 G	7·7	19	45	6·34	2·120		51	34	56·9	9·14	·28
R 4507	6·4	19	47	49.90	2·078		50	10	34·3	9·35	·27
R 4508 BAC +	5·1	19	47	53·43	2·138		51	51	45·1	9·35	·28
Ra 4519	6·9	19	49	30·03	2·150		51	53	44·0	9·43	·28
R 4522	7·4	19	49	39·98	2·143		51	57	8·6	9·49	·28
Ra 4558 G	7·9	19	53	35·47	2·087		50	3	59·0	9·78	·26
Ra 4571 G	7·7	19	55	8·13	2·096		50	11	45·8	9·90	·25
Ra 4590	7·1	19	58	24·13	2·140		51	16	52·7	10·15	·26

Year and Dominical Letter		19h R.A. m sec	20h R.A. m sec
1868	Jan. 1	3 46·34	3 46·44
E	July 2	3 46·23	3 46·31
	Dec. 32	3 46·12	3 46·18
1869	Jan. 1	0 47·34	0 47·41
C	July 3	0 47·25	0 47·29
	Dec. 32	0 47·16	0 47·19
1870	Jan. 1	1 44·30	1 44·33
B	July 3	1 44·23	1 44·24
	Dec. 32	1 44·19	1 44·17
1871	Jan. 1	2 41·32	2 41·31
A	July 3	2 41·29	2 41·26
	Dec. 32	2 41·28	2 41·23
1872	Jan. 1	3 38·42	3 38·36
G	July 2	3 38·43	3 38·36
	Dec. 32	3 38·46	3 38·37
1873	Jan. 1	0 39·69	0 39·60
E	July 3	0 39·74	0 39·64
	Dec. 32	0 39·80	0 39·69
1874	Jan. 1	1 36·94	1 36·83
D	July 3	1 37·02	1 36·90
	Dec. 32	1 37·11	1 36·99
1875	Jan. 1	2 34·25	2 34·13
C	July 3	2 34·36	2 34·23
	Dec. 32	2 34·47	2 34·35
1876	Jan. 1	3 31·60	3 31·48
B	July 2	3 31·72	3 31·61
	Dec. 32	3 31·84	3 31·73
1877	Jan. 1	0 33·06	0 32·96
G	July 3	0 33·18	0 33·09
	Dec. 32	0 33·29	0 33·21
1878	Jan. 1	1 30·43	1 30·35
F	July 3	1 30·53	1 30·47
	Dec. 32	1 30·62	1 30·58
1879	Jan. 1	2 27·76	2 27·72
E	July 3	2 27·84	2 27·82
	Dec. 32	2 27·90	2 27·90
1880	Jan. 1	3 25·04	3 25·04
D	July 2	3 25·08	3 25·11
	Dec. 32	3 25·11	3 25·15

		19h R.A. sec	20h R.A. sec
Jan.	1	8·30	8·40
	11	8·38	8·42
	21	8·52	8·48
	31	8·70	8·58
Feb.	10	8·92	8·73
	20	9·17	8·93
Mar.	2	9·46	9·16
	12	9·78	9·42
	22	10·09	9·72
Apr.	1	10·43	10·03
	11	10·77	10·37
	21	11·10	10·71
May	1	11·43	11·06
	11	11·73	11·40
	21	12·02	11·72
	31	12·26	12·02
June	10	12·48	12·29
	20	12·65	12·52
	30	12·77	12·71
July	10	12·84	12·86
	20	12·85	12·95
	30	12·82	12·99
Aug.	9	12·74	12·97
	19	12·61	12·90
	29	12·44	12·79
Sept.	8	12·23	12·63
	18	12·00	12·44
	28	11·75	12·22
Oct.	8	11·49	11·98
	18	11·23	11·74
	28	10·99	11·49
Nov.	7	10·78	11·26
	17	10·60	11·05
	27	10·45	10·87
Dec.	7	10·35	10·73
	17	10·31	10·62
	27	10·32	10·56
	37	10·37	10·55

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec.	°	′	″	Annual − ″	Secular − ″
Ra 4607 WB	7·3	20	0	49·76	2·123		50	35	13·2	10·35	·27
Ra 4628 G	7·7	20	3	21·40	2·161		51	34	27·1	10·54	·28
R 4632 G	7·6	20	3	33·69	2·160		51	30	46·7	10·54	·26
R 4650 G	7·1	20	5	17·12	2·168		51	37	53·6	10·68	·27
R 4651 G	7·6	20	5	18·04	2·169		51	40	6·3	10·67	·26
R 4662	7·8	20	6	26·97	2·120		50	4	16·1	10·75	·24
R 4684 G	6·8	20	7	57·30	2·171		51	30	19·2	10·88	·27
R 4694	5·3	20	8	54·86	2·125		50	2	30·6	10·94	·26
R 4702 G	6·6	20	9	21·15	2·152		50	48	54·7	10·97	·26
R 4717	7·7	20	10	37·98	2·132		50	11	4·9	11·06	·26
R 4719 G	6·	20	10	50·37	2·175		51	24	28·7	11·08	·26
R 4722 G	7·4	20	11	2·33	2·167		51	8	22·9	11·11	·28
R 4726 G	7·7	20	11	23·80	2·185		51	40	55·3	11·12	·26
Ra 4735 Σ	6·4	20	12	9·10	2·166		51	0	42·7	11·19	·27
R 4741 G	7·9	20	12	59·35	2·180		51	23	10·4	11·25	·27
2 Gre 1315 BAC Cygy	3·2	20	14	10·02	2·147		50	9	51·9	11·35	·26
R 4752 G	6·9	20	14	49·12	2·179		51	12	42·8	11·37	·26
Rad 4771 G	7·	20	16	43·20	2·154		50	16	28·4	11·51	·26
R 4777 A	7·5	20	17	21·05	2·167		50	38	10·7	11·55	·26
R 4778 G	7·8	20	17	23·88	2·158		50	19	55·4	11·55	·26
Ra 4781	6·9	20	17	58·70	2·150		50	1	46·4	11·59	·25
R 4787 G	7·7	20	18	37·88	2·153		50	5	8·7	11·64	·24
R 4793 WB	7·4	20	19	14·88	2·175		50	42	6·9	11·68	·26
BAC 7061	6·	20	19	20·43	2·215		51	59	33·0	11·66	·26
R 4836 WB	7·4	20	23	16·08	2·180		50	30	24·8	11·97	·26
Ra 4914 G	6·5	20	32	41·43	2·234		51	23	11·1	12·63	·26
R 4970 G	7·5	20	40	36·28	2·265		51	37	21·4	13·16	·25
R 5025 WB	7·7	20	47	13·42	2·264		50	52	51.1	13·59	·24
Ra 5037 G	7·2	20	49	9·24	2·270		50	50	45·3	13·72	·24
R 5041 G	7·6	20	49	31·70	2·253		50	14	11·3	13·75	·24
R 5061	6·8	20	51	12·21	2·300		51	41	24·9	13·85	·24
Ra 5076 Σ	7·4	20	53	19·87	2·294		51	15	24·7	13·98	·25
Radc 5085 BAC	6·4	20	54	31·48	2·315		51	51	46·8	14·06	·24
3 Green 1742 R	5·6	20	57	32·24	2·666		51	53	53·9	17·46	·23
3 Green 1743 R	5·6	20	57	33·80	2·672		51	54	1·6	17·24	·23
Radc 5118	7·7	20	59	29·41	2·334		52	0	10·9	14·37	·24

Year and Dominical Letter		20h R.A. m sec	21h R.A. m sec
1868	Jan. 1	3 46·44	3 46·51
E	July 2	3 46·31	3 46·36
	Dec. 32	3 46·18	3 46·22
1869	Jan. 1	0 47·41	0 47·45
C	July 3	0 47·29	0 47·31
	Dec. 32	0 47·19	0 47·19
1870	Jan. 1	1 44·33	1 44·32
B	July 3	1 44·24	1 44·22
	Dec. 32	1 44·17	1 44·13
1871	Jan. 1	2 41·31	2 41·26
A	July 3	2 41·26	2 41·20
	Dec. 32	2 41·23	2 41·15
1872	Jan. 1	3 38·36	3 38·29
G	July 2	3 38·36	3 38·27
	Dec. 32	3 38·37	3 38·27
1873	Jan. 1	0 39·60	0 39·50
E	July 3	0 39·64	0 39·53
	Dec. 32	0 39·69	0 39·58
1874	Jan. 1	1 36·83	1 36·71
D	July 3	1 36·90	1 36·79
	Dec. 32	1 36·99	1 36·88
1875	Jan. 1	2 34·13	2 34·01
C	July 3	2 34·23	2 34·12
	Dec. 32	2 34·35	2 34·24
1876	Jan. 1	3 31·48	3 31·38
B	July 2	3 31·61	3 31·51
	Dec. 32	3 31·73	3 31·65
1877	Jan. 1	0 32·96	0 32·88
G	July 3	0 33·09	0 33·02
	Dec. 32	0 33·21	0 33·16
1878	Jan. 1	1 30·35	1 30·30
F	July 3	1 30·47	1 30·44
	Dec. 32	1 30·58	1 30·57
1879	Jan. 1	2 27·72	2 27·71
E	July 3	2 27·82	2 27·83
	Dec. 32	2 27·90	2 27·93
1880	Jan. 1	3 25·04	3 25·07
D	July 2	3 25·11	3 25·15
	Dec. 32	3 25·15	3 25·22

	20h R.A. sec	21h R.A. sec
Jan. 1	8·40	8·62
11	8·42	8·56
21	8·48	8·55
31	8·58	8·58
Feb. 10	8·73	8·66
20	8·93	8·79
Mar. 2	9·16	8·95
12	9·42	9·16
22	9·72	9·41
Apr. 1	10·03	9·69
11	10·37	10·00
21	10·71	10·33
May 1	11·06	10·67
11	11·40	11·03
21	11·72	11·38
31	12·02	11·72
June 10	12·29	12·04
20	12·52	12·33
30	12·71	12·58
July 10	12·86	12·79
20	12·95	12·96
30	12·99	13·07
Aug. 9	12·97	13·13
19	12·90	13·14
29	12·79	13·09
Sept. 8	12·63	13·00
18	12·44	12·86
28	12·22	12·69
Oct. 8	11·98	12·50
18	11·74	12·28
28	11·49	12·06
Nov. 7	11·26	11·83
17	11·05	11·62
27	10·87	11·42
Dec. 7	10·73	11·24
17	10·62	11·09
27	10·56	10·98
37	10·55	10·90

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME: Right Ascension			Variation		North Polar Dist.			Variation	
		h	m	s	Annual sec. +	Secular sec. +	°	′	″	Annual − ″	Secular − ″
3 Gre 1756 BAC Cygr	4·	21	6	3·39	2·385	·005	52	31	0·99	15·23	·23
3 G 1760 R Cyg σ	4·5	21	8	45·60	2·349	·005	51	9	27·19	14·91	·22
Ra 5173	7·7	21	8	58·04	2·335	·003	50	48	24 ·3	14·94	·23
R 5181 WB	7·	21	10	20·48	2·340	·003	50	48	23 ·3	15·02	·23
WB 564 L	8·	21	20	20·03	2·366	·006	50	16	24 ·0	15·58	·21
BAC 7505 WB	5·5	21	25	51·90	2·440	·004	52	3	23 ·5	16·00	·12
R 5292 *	7·6	21	26	6·86	2·406	·004	51	9	5 ·8	15·89	·20
Ra 5309 G	6·	21	28	7·93	2·392	·005	50	10	41 ·1	16·00	·20
R 5316 G	6·8	21	28	55·81	2·437	·005	51	16	32 ·7	16·05	·21
R 5337 G	7·2	21	30	59·31	2·424	·006	51	4	56 ·3	16·15	·21
R 5353 G	7·9	21	32	23·97	2·430	·005	51	7	31 ·7	16·22	·21
Ra 5359 G	7·2	21	33	19·02	2·433	·005	51	4	32 ·9	16·27	·21
1 Gr 1936	5·6	21	34	25·50	2·469	·005	52	19	10 ·0	16·35	·21
1 G 1937 WB	7·	21	34	36·54	2·465	·005	52	17	52 ·4	16·36	·21
Ra 5398 G	7·2	21	39	17·32	2·468	·006	51	39	20 ·6	16·57	·20
R 5413	7·4	21	41	25·54	2·466	·006	51	10	24 ·6	16·68	·20
Ra 5426 G	6·2	21	42	3·48	2·466	·006	51	4	50 ·1	16·71	·20
R 5503 WB	7·4	21	51	44·72	2·505	·008	51	6	25 ·8	17·17	·19
R 5507 WB	7·1	21	51	57·47	2·512	·008	51	23	15 ·1	17·18	·20
R 5520	7·9	21	53	45·07	2·513	·008	51	4	25 ·4	17·26	·19

* R 5292 RA by G 21 26 6·34

Year and Dominical Letter		21h R.A. m sec	22h R.A. m sec
1868	Jan. 1	3 46·51	3 46·55
E	July 2	3 46·36	3 46·39
	Dec. 32	3 46·22	3 46·23
1869	Jan. 1	0 47·45	0 47·45
C	July 3	0 47·31	0 47·30
	Dec. 32	0 47·19	0 47·16
1870	Jan. 1	1 44·32	1 44·29
B	July 3	1 44·22	1 44·17
	Dec. 32	1 44·13	1 44·07
1871	Jan. 1	2 41·26	2 41·20
A	July 3	2 41·20	2 41·12
	Dec. 32	2 41·15	2 41·06
1872	Jan. 1	3 38·29	3 38·20
G	July 2	3 38·27	3 38·17
	Dec. 32	3 38·27	3 38·17
1873	Jan. 1	0 39·50	0 39·40
E	July 3	0 39·53	0 39·42
	Dec. 32	0 39·58	0 39·47
1874	Jan. 1	1 36·71	1 36·61
D	July 3	1 36·79	1 36·68
	Dec. 32	1 36·88	1 36·78
1875	Jan. 1	2 34·01	2 33·92
C	July 3	2 34·12	2 34·03
	Dec. 32	2 34·24	2 34·16
1876	Jan. 1	3 31·38	3 31·30
B	July 2	3 31·51	3 31·44
	Dec. 32	3 31·65	3 31·60
1877	Jan. 1	0 32·88	0 32·82
G	July 3	0 33·02	0 32·98
	Dec. 32	0 33·16	0 33·14
1878	Jan. 1	1 30·30	1 30·28
F	July 3	1 30·44	1 30·44
	Dec. 32	1 30·57	1 30·59
1879	Jan. 1	2 27·71	2 27·72
E	July 3	2 27·83	2 27·86
	Dec. 32	2 27·93	2 27·98
1880	Jan. 1	3 25·07	3 25·12
D	July 2	3 25·15	3 25·22
	Dec. 32	3 25·22	3 25·30

	21h R.A. sec	22h R.A. sec
Jan. 1	8·62	8·93
11	8·56	8·82
21	8·55	8·75
31	8·58	8·71
Feb. 10	8·66	8·71
20	8·79	8·76
Mar. 2	8·95	8·86
12	9·16	9·00
22	9·41	9·18
April 1	9·69	9·41
11	10·00	9·68
21	10·33	9·98
May 1	10·67	10·31
11	11·03	10·66
21	11·38	11·02
31	11·72	11·38
June 10	12·04	11·74
20	12·33	12·07
30	12·58	12·38
July 10	12·79	12·66
20	12·96	12·89
30	13·07	13·08
Aug. 9	13·13	13·21
19	13·14	13·29
29	13·09	13·33
Sept. 8	13·00	13·31
18	12·86	13·25
28	12·69	13·14
Oct. 8	12·50	13·00
18	12·28	12·84
28	12·06	12·65
Nov. 7	11·83	12·45
17	11·62	12·25
27	11·42	12·05
Dec. 7	11·24	11·86
17	11·09	11·69
27	10·98	11·54
37	10·90	11·41

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec. +	°	′	″	Annual − ″	Secular − ″
Ra 5589 A	7·7	22	2	1·47	2·535	·008	50	28	50·8	17·61	·18
3 Gr 1859 R	5·	22	4	35·41	2·570	·011	50	56	22·31	17·56	·17
3 G 1861 BAC	5·4	22	6	35·14	2·601	·011	52	54	28·30	17·82	·17
WB 467 L	7·	22	17	59·88	2·613	·013	50	51	43·1	18·24	·15
R 5731	7·9	22	22	52·87	2·619	·011	50	3	43·4	18·42	·15
R 5732 WB	6·2	22	22	55·79	2·633	·011	50	53	54·7	18·42	·15
Ra 5752	7·5	22	25	54·28	2·648	·011	51	5	48·7	18·52	·15
Ra 5755 Σ Σ	6·6	22	26	18·80	2·648	·011	51	3	21·3	18·26	·15
R 5756 Σ	6·1	22	26	18·85	2·649	·011	51	2	53·7	18·53	·15
R 5757	7·2	22	26	38·28	2·656	·012	51	20	41·8	18·54	·15
R 5780 G	5·8	22	29	38·79	2·672	·012	51	38	9·8	18·65	·15
R 5793 G	5·7	22	31	52·18	2·666	·012	50	27	47·7	18·70	·14
Ra 5808 G	6·1	22	34	25·37	2·688	·013	51	13	31·9	18·78	·14
R 5813 G	6·4	22	35	11·85	2·694	·013	51	29	27·8	18·81	·14
R 5863 G	7·6	22	42	35·74	2·714	·014	50	26	4·5	19·03	·13
Ra 5869 G	6·4	22	43	25·73	2·719	·014	50	31	59·6	19·05	·13
Ra 5894 G	7·4	22	47	46·17	2·747	·014	51	18	59·0	19·17	·12
R 5895 WB	7·1	22	47	50·45	2·749	·014	51	23	46·4	19·17	·12
R 5970 WB	7·5	22	58	47·39	2·799	·016	51	32	45·2	19·42	·10
R 5973 WB	7·4	22	58	57·70	2·802	·015	51	47	57·0	19·44	·11
R 5977 G	7·	22	59	53·12	2·801	·016	51	14	44·4	19·45	·9

Year and Dominical Letter		22h R.A. m sec	23h R.A. m sec
1868	Jan. 1	3 46·55	3 46·57
E	July 2	3 46·39	3 46·38
	Dec. 32	3 46·23	3 46·20
1869	Jan. 1	0 47·45	0 47·43
C	July 3	0 47·30	0 47·26
	Dec. 32	0 47·16	0 47·10
1870	Jan. 1	1 44·29	1 44·24
B	July 3	1 44·17	1 44·10
	Dec. 32	1 44·07	1 43·99
1871	Jan. 1	2 41·20	2 41·12
A	July 3	2 41·12	2 41·03
	Dec. 32	2 41·06	2 40·97
1872	Jan. 1	3 38·20	3 38·11
G	July 2	3 38·17	3 38·07
	Dec. 32	3 38·17	3 38·07
1873	Jan. 1	0 39·40	0 39·30
E	July 3	0 39·42	0 39·32
	Dec. 32	0 39·47	0 39·37
1874	Jan. 1	1 36·61	1 36·51
D	July 3	1 36·68	1 36·59
	Dec. 32	1 36·78	1 36·70
1875	Jan. 1	2 33·92	2 33·84
C	July 3	2 34·03	2 33·96
	Dec. 32	2 34·16	2 34·11
1876	Jan. 1	3 31·30	3 31·24
B	July 2	3 31·44	3 31·41
	Dec. 32	3 31·60	3 31·57
1877	Jan. 1	0 32·82	0 32·80
G	July 3	0 32·98	0 32·98
	Dec. 32	0 33·14	0 33·15
1878	Jan. 1	1 30·28	1 30·29
F	July 3	1 30·44	1 30·46
	Dec. 32	1 30·59	1 30·63
1879	Jan. 1	2 27·72	2 27·76
E	July 3	2 27·86	2 27·92
	Dec. 32	2 27·98	2 28·05
1880	Jan. 1	3 25·12	3 25·19
D	July 2	3 25·22	3 25·30
	Dec. 32	3 25·30	3 25·39

	22h R.A. sec	23h R.A. sec
Jan. 1	8·93	9·31
11	8·82	9·17
21	8·75	9·04
31	8·71	8·94
Feb. 10	8·71	8·88
20	8·76	8·86
Mar. 2	8·86	8·88
12	9·00	8·94
22	9·18	9·06
April 1	9·41	9·23
11	9·68	9·44
21	9·98	9·70
May 1	10·31	9·99
11	10·66	10·32
21	11·02	10·67
31	11·38	11·04
June 10	11·74	11·41
20	12·07	11·77
30	12·38	12·12
July 10	12·66	12·45
20	12·89	12·74
30	13·08	12·99
Aug. 9	13·21	13·20
19	13·29	13·36
29	13·33	13·48
Sept. 8	13·31	13·54
18	13·25	13·56
28	13·14	13·53
Oct. 8	13·00	13·46
18	12·84	13·36
28	12·65	13·23
Nov. 7	12·45	13·08
17	12·25	12·91
27	12·05	12·73
Dec. 7	11·86	12·55
17	11·69	12·37
27	11·54	12·20
37	11·41	12·04

TABLE I.

MEAN PLACES OF FIXED STARS FOR JAN. 1, 1868.

Authority and Star's Name	Mag.	Expressed in MEAN SOLAR TIME					North Polar Dist.			Variation	
		Right Ascension			Variation						
		h	m	s	Annual sec. +	Secular sec. +	°	′	″	Annual − ″	Secular − ″
Ra 5998 WB	7·5	23	3	4·14	2·812	·018	50	42	54·0	19·51	·10
R 6034 WB	7·6	23	9	37·33	2·847	·017	51	25	54·7	19·64	·08
BAC 8136	6·	23	10	43·19	2·876	·017	52	32	15·4	19·62	·08
Ra 6096 G	5·8	23	20	58·04	2·926	·019	51	29	17·7	19·77	·07
1 G 2111 R	6·	23	24	19·80	2·913	·020	50	29	27·9	19·83	·06
WB 689–90	8·	23	28	18·85	2·937	·022	51	41	8·2	19·91	·05
WB 805–6	8·9	23	33	20·45	2·964	·021	52	49	5·5	19·95	·04
Ra 6211	6·8	23	43	29·56	3·003	·022	51	27	10·6	20·02	·02
R 6233 WB	7·6	23	47	45·56	3·024	·023	51	46	13·0	20·04	·02
R 6242 G	7·3	23	48	15·40	3·026	·023	51	37	20·5	20·04	·02
R 6252 G	6·6	23	49	22·61	3·031	·023	51	52	30·8	20·04	·01
Ra 6316 G	7·3	23	56	52·78	3·065	.023	50	39	21·0	20·05	·00
R 6317 G	6·8	23	56	53·82	3·065	·023	50	35	9·8	20·05	·00

Year and Dominical Letter		23h R.A. m	sec	24h R.A. m	sec
1868	Jan. 1	3	46·57	3	46·55
E	July 2	3	46·38	3	46·35
	Dec. 32	3	46·20	3	46·15
1869	Jan. 1	0	47·43	0	47·38
C	July 3	0	47·26	0	47·20
	Dec. 32	0	47·10	0	47·03
1870	Jan. 1	1	44·24	1	44·16
B	July 3	1	44·10	1	44·02
	Dec. 32	1	43·99	1	43·90
1871	Jan. 1	2	41·12	2	41·03
A	July 3	2	41·03	2	40·94
	Dec. 32	2	40·97	2	40·87
1872	Jan. 1	3	38·11	3	38·01
G	July 2	3	38·07	3	37·98
	Dec. 32	3	38·07	3	37·98
1873	Jan. 1	0	39·30	0	39·21
E	July 3	0	39·32	0	39·24
	Dec. 32	0	39·37	0	39·30
1874	Jan. 1	1	36·51	1	36·44
D	July 3	1	36·59	1	36·53
	Dec. 32	1	36·70	1	36·65
1875	Jan. 1	2	33·84	2	33·79
C	July 3	2	33·96	2	33·93
	Dec. 32	2	34·11	2	34·09
1876	Jan. 1	3	31·24	3	31·22
B	July 2	3	31·41	3	31·40
	Dec. 32	3	31·57	3	31·59
1877	Jan. 1	0	32·80	0	32·81
G	July 3	0	32·98	0	33·00
	Dec. 32	0	33·15	0	33·19
1878	Jan. 1	1	30·29	1	30·33
F	July 3	1	30·46	1	30·52
	Dec. 32	1	30·63	1	30·69
1879	Jan. 1	2	27·77	2	27·83
E	July 3	2	27·92	2	27·99
	Dec. 32	2	28·05	2	28·14
1880	Jan. 1	2	25·19	3	25·27
D	July 2	2	25·30	3	25·39
	Dec. 32	2	25·39	3	25·48

	23h R.A. sec	24h R.A. sec
Jan. 1	9·31	9·75
11	9·17	9·58
21	9·04	9·42
31	8·94	9·27
Feb. 10	8·88	9·15
20	8·86	9·06
Mar. 2	8·88	9·01
12	8·94	9·01
22	9·06	9·05
April 1	9·23	9·14
11	9 44	9·29
21	9·70	9·49
May 1	9·99	9·74
11	10·32	10·03
21	10·67	10·35
31	11·04	10·71
June 10	11·41	11·07
20	11·77	11·45
30	12·12	11·83
July 10	12·45	12·19
20	12·74	12·53
30	12·99	12·84
Aug. 9	13·20	13·11
19	13·36	13·34
29	13·48	13·53
Sept. 8	13·54	13·68
18	13·56	13·78
28	13·53	13·83
Oct. 8	13·46	13·85
18	13·36	13·82
28	13·23	13·76
Nov. 7	13·08	13·67
17	12·91	13·55
27	12·73	13·41
Dec. 7	12·55	13·26
17	12·37	13·09
27	12·20	12·92
37	12·04	12·74

TABLE IV.

JANUARY					FEBRUARY					MARCH				
D. L.	Day	P.M. h	m	s	D. L.	Day	P.M. h	m	s	D. L.	Day	P.M. h	m	s
A	1	5	13	28·00	D	1	3	11	34·81	D	1	1	21	29·34
B	2	5	9	32·09	E	2	3	7	38·90	E	2	1	17	33·43
C	3	5	5	36·18	F	3	3	3	42·99	F	3	1	13	37·52
D	4	5	1	40·27	G	4	2	59	47·08	G	4	1	9	41·61
E	5	4	57	44·36	A	5	2	55	51·17	A	5	1	5	45·70
F	6	4	53	48·45	B	6	2	51	55·26	B	6	1	1	49·80
G	7	4	49	52·54	C	7	2	47	59·35	C	7	0	57	53·89
A	8	4	45	56·63	D	8	2	44	3·44	D	8	0	53	57·98
B	9	4	42	0·72	E	9	2	40	7·53	E	9	0	50	2·07
C	10	4	38	4·81	F	10	2	36	11·62	F	10	0	46	6·16
D	11	4	34	8·91	G	11	2	32	15·71	G	11	0	42	10·25
E	12	4	30	13·00	A	12	2	28	19 80	A	12	0	38	14·34
F	13	4	26	17·09	B	13	2	24	23·89	B	13	0	34	18·43
G	14	4	22	21·18	C	14	2	20	27·98	C	14	0	30	22·52
A	15	4	18	25·27	D	15	2	16	32·07	D	15	0	26	26·61
B	16	4	14	29·36	E	16	2	12	36·17	E	16	0	22	30·70
C	17	4	10	33·45	F	17	2	8	40·26	F	17	0	18	34·79
D	18	4	6	37·54	G	18	2	4	44·35	G	18	0	14	38·88
E	19	4	2	41·63	A	19	2	0	48·44	A	19	0	10	42·97
F	20	3	58	45·72	B	20	1	56	52·53	B	20	0	6	47·06
G	21	3	54	49·81	C	21	1	52	56·62	C	21	0	2	51·15
A	22	3	50	53·90	D	22	1	49	0·71			P.M.		
B	23	3	46	57·99	E	23	1	45	4·80			A.M.		
C	24	3	43	2 08	F	24	1	41	8·89	D	22	11	58	55·24
D	25	3	39	6·17	G	25	1	37	12·98	E	23	11	54	59·33
E	26	3	35	10·26	A	26	1	33	17·07	F	24	11	51	3·43
F	27	3	31	14·35	B	27	1	29	21·16	G	25	11	47	7·52
G	28	3	27	18·44	C	28	1	25	25·25	A	26	11	43	11·61
A	29	3	23	22·54			P M.			B	27	11	39	15·70
B	30	3	19	26·63						C	28	11	35	19·79
C	31	3	15	30·72						D	29	11	31	23·88
		P.M.								E	30	11	27	27·97
										F	31	11	23	32·06
												A.M.		

RULE.—To find the Mean Time at Greenwich of the transit of the Mean Equinox on any day: Add the Equinox Correction for the Year from Table V. to the time for the day given in Table IV., and the sum will be the time required.

TABLE IV.

APRIL					MAY					JUNE				
D. L.	Day	A.M. h	m	s	D. L.	Day	A.M. h	m	s	D. L.	Day	A.M. h	m	s
G	1	11	19	36·15	B	1	9	21	38·87	E	1	7	19	45·67
A	2	11	15	40·24	C	2	9	17	42·96	F	2	7	15	49·76
B	3	11	11	44·33	D	3	9	13	47·05	G	3	7	11	53·85
C	4	11	7	48·42	E	4	9	9	51·14	A	4	7	7	57·94
D	5	11	3	52·51	F	5	9	5	55·23	B	5	7	4	2·04
E	6	10	59	56·60	G	6	9	1	59·32	C	6	7	0	6·13
F	7	10	56	0·69	A	7	8	58	3·41	D	7	6	56	10·22
G	8	10	52	4·78	B	8	8	54	7·50	E	8	6	52	14·31
A	9	10	48	8·87	C	9	8	50	11·59	F	9	6	48	18·40
B	10	10	44	12·96	D	10	8	46	15·68	G	10	6	44	22·49
C	11	10	40	17·05	E	11	8	42	19·77	A	11	6	40	26·58
D	12	10	36	21·15	F	12	8	38	23·86	B	12	6	36	30·67
E	13	10	32	25·24	G	13	8	34	27·95	C	13	6	32	34·76
F	14	10	28	29·33	A	14	8	30	32·04	D	14	6	28	38·85
G	15	10	24	33·42	B	15	8	26	36·13	E	15	6	24	42·94
A	16	10	20	37·51	C	16	8	22	40·22	F	16	6	20	47·03
B	17	10	16	41·60	D	17	8	18	44·31	G	17	6	16	51·12
C	18	10	12	45·69	E	18	8	14	48·41	A	18	6	12	55·21
D	19	10	8	49·78	F	19	8	10	52·50	B	19	6	8	59·30
E	20	10	4	53·87	G	20	8	6	56·59	C	20	6	5	3·39
F	21	10	0	57·96	A	21	8	3	0·68	D	21	6	1	7·48
G	22	9	57	2·05	B	22	7	59	4·77	E	22	5	57	11·57
A	23	9	53	6·14	C	23	7	55	8·86	F	23	5	53	15·67
B	24	9	49	10·23	D	24	7	51	12·95	G	24	5	49	19·76
C	25	9	45	14·32	E	25	7	47	17·04	A	25	5	45	23·85
D	26	9	41	18·41	F	26	7	43	21·13	B	26	5	41	27·94
E	27	9	37	22·50	G	27	7	39	25·22	C	27	5	37	32·03
F	28	9	33	26·59	A	28	7	35	29·31	D	28	5	33	36·12
G	29	9	29	30·68	B	29	7	31	33·40	E	29	5	29	40·21
A	30	9	25	34·78	C	30	7	27	37·49	F	30	5	25	44·30
				A.M	D	31	7	23	41·58					A M.
									A.M.					

TABLE IV.

JULY					AUGUST					SEPTEMBER				
D. L.	Day	A.M. h	m	s	D. L.	Day	A.M. h	m	s	D. L.	Day	A.M. h	m	s
G	1	5	21	48·39	C	1	3	19	55·20	F	1	1	18	2·00
A	2	5	17	52·48	D	2	3	15	59·29	G	2	1	14	6·09
B	3	5	13	56·57	E	3	3	12	3·38	A	3	1	10	10·18
C	4	5	10	0·66	F	4	3	8	7·47	B	4	1	6	14·28
D	5	5	6	4·75	G	5	3	4	11·56	C	5	1	2	18·37
E	6	5	2	8·84	A	6	3	0	15·65	D	6	0	58	22·46
F	7	4	58	12·93	B	7	2	56	19·74	E	7	0	54	26·55
G	8	4	54	17·02	C	8	2	52	23·83	F	8	0	50	30·64
A	9	4	50	21·11	D	9	2	48	27·92	G	9	0	46	34·73
B	10	4	46	25·20	E	10	2	44	32·01	A	10	0	42	38·82
C	11	4	42	29·29	F	11	2	40	36·10	B	11	0	38	42·91
D	12	4	38	33·39	G	12	2	36	40·19	C	12	0	34	47·00
E	13	4	34	37·48	A	13	2	32	44·28	D	13	0	30	51·09
F	14	4	30	41·57	B	14	2	28	48·37	E	14	0	26	55·18
G	15	4	26	45·66	C	15	2	24	52·46	F	15	0	22	59·27
A	16	4	22	49·75	D	16	2	20	56·55	G	16	0	19	3·36
B	17	4	18	53·84	E	17	2	17	0·65	A	17	0	15	7·45
C	18	4	14	57·93	F	18	2	13	4·74	B	18	0	11	11·54
D	19	4	11	2·02	G	19	2	9	8·83	C	19	0	7	15·63
E	20	4	7	6·11	A	20	2	5	12·92	D	20	0	3	19·72
												A.M.		
F	21	4	3	10·20	B	21	2	1	17·01			P.M.		
G	22	3	59	14·29	C	22	1	57	21·10	D	20	11	59	23·81
A	23	3	55	18·38	D	23	1	53	25·19	E	21	11	55	27·91
B	24	3	51	22·47	E	24	1	49	29·28	F	22	11	51	32·00
C	25	3	47	26·56	F	25	1	45	33·37	G	23	11	47	36·09
D	26	3	43	30·65	G	26	1	41	37·46	A	24	11	43	40·18
E	27	3	39	34·74	A	27	1	37	41·55	B	25	11	39	44·27
F	28	3	35	38·83	B	28	1	33	45·64	C	26	11	35	48·36
G	29	3	31	42·92	C	29	1	29	49·73	D	27	11	31	52·45
A	30	3	27	47·02	D	30	1	25	53·82	E	28	11	27	56·54
B	31	3	23	51·11	E	31	1	21	57·91	F	29	11	24	0·63
										G	30	11	20	4·72
		A M.					A.M.					P M.		

TABLE IV.

OCTOBER					NOVEMBER					DECEMBER				
D.L.	Day	P.M. h	m	s	D.L.	Day	P.M. h	m	s	D.L.	Day	P.M. h	m	s
A	1	11	16	8·81	D	1	9	14	15·62	F	1	7	16	18·33
B	2	11	12	12·90	E	2	9	10	19·71	G	2	7	12	22·42
C	3	11	8	16·99	F	3	9	6	23·80	A	3	7	8	26·52
D	4	11	4	21·08	G	4	9	2	27·89	B	4	7	4	30·61
E	5	11	0	25·17	A	5	8	58	31·98	C	5	7	0	34·70
F	6	10	56	29·26	B	6	8	54	36·07	D	6	6	56	38·79
G	7	10	52	33·35	C	7	8	50	40·16	E	7	6	52	42·88
A	8	10	48	37·44	D	8	8	46	44·25	F	8	6	48	46·97
B	9	10	44	41·54	E	9	8	42	48·34	G	9	6	44	51·06
C	10	10	40	45·63	F	10	8	38	52·43	A	10	6	40	55·15
D	11	10	36	49·72	G	11	8	34	56·52	B	11	6	36	59·24
E	12	10	32	53·81	A	12	8	31	0·61	C	12	6	33	3·33
F	13	10	28	57·90	B	13	8	27	4·70	D	13	6	29	7·42
G	14	10	25	1·99	C	14	8	23	8·79	E	14	6	25	11·51
A	15	10	21	6·08	D	15	8	19	12·89	F	15	6	21	15·60
B	16	10	17	10·17	E	16	8	15	16·98	G	16	6	17	19·69
C	17	10	13	14·26	F	17	8	11	21·07	A	17	6	13	23·78
D	18	10	9	18·35	G	18	8	7	25·16	B	18	6	9	27·87
E	19	10	5	22·44	A	19	8	3	29·25	C	19	6	5	31·96
F	20	10	1	26·53	B	20	7	59	33·34	D	20	6	1	36·05
G	21	9	57	30·62	C	21	7	55	37·43	E	21	5	57	40·15
A	22	9	53	34·71	D	22	7	51	41·52	F	22	5	53	44·24
B	23	9	49	38·80	E	23	7	47	45·61	G	23	5	49	48·33
C	24	9	45	42·89	F	24	7	43	49·70	A	24	5	45	52·42
D	25	9	41	46·98	G	25	7	39	53·79	B	25	5	41	56·51
E	26	9	37	51·07	A	26	7	35	57·88	C	26	5	38	0·60
F	27	9	33	55·16	B	27	7	32	1·97	D	27	5	34	4·69
G	28	9	29	59·26	C	28	7	28	6·06	E	28	5	30	8·78
A	29	9	26	3·35	D	29	7	24	10·15	F	29	5	26	12·87
B	30	9	22	7·44	E	30	7	20	14·24	G	30	5	22	16·96
C	31	9	18	11·53						A	31	5	18	21·05
				P.M.					P M.					P.M.

TABLE IV.

JANUARY Leap Year			FEBRUARY Leap Year			MARCH Leap Year		
D.L.	Day	P.M. h m s	D.L.	Day	P.M. h m s	D.L.	Day	P.M. h m s
A	1	5 13 28·00	D	1	3 11 34·81	E	1	1 17 33·43
B	2	5 9 32·09	E	2	3 7 38·90	F	2	1 13 37·52
C	3	5 5 36·18	F	3	3 3 42·99	G	3	1 9 41·61
D	4	5 1 40·27	G	4	2 59 47·08	A	4	1 5 45·70
E	5	4 57 44·36	A	5	2 55 51·17	B	5	1 1 49·80
F	6	4 53 48·45	B	6	2 51 55·26	C	6	0 57 53·89
G	7	4 49 52·54	C	7	2 47 59·35	D	7	0 53 57·98
A	8	4 45 56·63	D	8	2 44 3·44	E	8	0 50 2·07
B	9	4 42 0·72	E	9	2 40 7·53	F	9	0 46 6·16
C	10	4 38 4·81	F	10	2 36 11·62	G	10	0 42 10·25
D	11	4 34 8·91	G	11	2 32 15·71	A	11	0 38 14·34
E	12	4 30 13·00	A	12	2 28 19·80	B	12	0 34 18·43
F	13	4 26 17·09	B	13	2 24 23·89	C	13	0 30 22·52
G	14	4 22 21·18	C	14	2 20 27·98	D	14	0 26 26·61
A	15	4 18 25·27	D	15	2 16 32·07	E	15	0 22 30·70
B	16	4 14 29·36	E	16	2 12 36·17	F	16	0 18 34·79
C	17	4 10 33·45	F	17	2 8 40·26	G	17	0 14 38·88
D	18	4 6 37·54	G	18	2 4 44·35	A	18	0 10 42·97
E	19	4 2 41·63	A	19	2 0 48·44	B	19	0 6 47·06
F	20	3 58 45·72	B	20	1 56 52·53	C	20	0 2 51·15
G	21	3 54 49·81	C	21	1 52 56·62			P.M. / A.M.
A	22	3 50 53·90	D	22	1 49 0·71	D	21	11 58 55·24
B	23	3 46 57·99	E	23	1 45 4·80	E	22	11 54 59·33
C	24	3 43 2·08	F	24	1 41 8·89	F	23	11 51 3·43
D	25	3 39 6·17	G	25	1 37 12·98	G	24	11 47 7·52
E	26	3 35 10·26	A	26	1 33 17·07	A	25	11 43 11·61
F	27	3 31 14·35	B	27	1 29 21·16	B	26	11 39 15·70
G	28	3 27 18·44	C	28	1 25 25·25	C	27	11 35 19·79
A	29	3 23 22·54	D	29	1 21 29·34	D	28	11 31 23·88
B	30	3 19 26·63			P.M.	E	29	11 27 27·97
C	31	3 15 30·72				F	30	11 23 32·06
		P.M.				G	31	11 19 36·15 A.M.

Rule.—To find the Mean Time at Greenwich of the transit of the Mean Equinox on any day: Add the Equinox Correction for the Year from Table V. to the time for the day given in Table IV., and the sum will be the time required.

TABLE IV.

APRIL Leap Year					MAY Leap Year					JUNE Leap Year				
D.L.	Day	A.M. h	m	s	D.L.	Day	A.M. h	m	s	D.L.	Day	A.M. h	m	s
A	1	11	15	40·24	C	1	9	17	42·96	F	1	7	15	49·76
B	2	11	11	44·33	D	2	9	13	47·05	G	2	7	11	53·85
C	3	11	7	48·42	E	3	9	9	51·14	A	3	7	7	57·94
D	4	11	3	52·51	F	4	9	5	55·23	B	4	7	4	2·04
E	5	10	59	56·60	G	5	9	1	59·32	C	5	7	0	6·13
F	6	10	56	0·69	A	6	8	58	3·41	D	6	6	56	10·22
G	7	10	52	4·78	B	7	8	54	7·50	E	7	6	52	14·31
A	8	10	48	8·87	C	8	8	50	11·59	F	8	6	48	18·40
B	9	10	44	12·96	D	9	8	46	15·68	G	9	6	44	22·49
C	10	10	40	17·05	E	10	8	42	19·77	A	10	6	40	26·58
D	11	10	36	21·15	F	11	8	38	23·86	B	11	6	36	30·67
E	12	10	32	25·24	G	12	8	34	27·95	C	12	6	32	34·76
F	13	10	28	29·33	A	13	8	30	32·04	D	13	6	28	38·85
G	14	10	24	33·42	B	14	8	26	36·13	E	14	6	24	42·94
A	15	10	20	37·51	C	15	8	22	40·22	F	15	6	20	47·03
B	16	10	16	41·60	D	16	8	18	44·31	G	16	6	16	51·12
C	17	10	12	45·69	E	17	8	14	48·41	A	17	6	12	55·21
D	18	10	8	49·78	F	18	8	10	52·50	B	18	6	8	59·30
E	19	10	4	53·87	G	19	8	6	56·59	C	19	6	5	3·39
F	20	10	0	57·96	A	20	8	3	0·68	D	20	6	1	7·48
G	21	9	57	2·05	B	21	7	59	4·77	E	21	5	57	11·57
A	22	9	53	6·14	C	22	7	55	8·86	F	22	5	53	15·67
B	23	9	49	10·23	D	23	7	51	12·95	G	23	5	49	19·76
C	24	9	45	14·32	E	24	7	47	17·04	A	24	5	45	23·85
D	25	9	41	18·41	F	25	7	43	21·13	B	25	5	41	27·94
E	26	9	37	22·50	G	26	7	39	25·22	C	26	5	37	32·03
F	27	9	33	26·59	A	27	7	35	29·31	D	27	5	33	36·12
G	28	9	29	30·68	B	28	7	31	33·40	E	28	5	29	40·21
A	29	9	25	34·78	C	29	7	27	37·49	F	29	5	25	44·30
B	30	9	21	38·87	D	30	7	23	41·58	G	30	5	21	48·39
		A.M.			E	31	7	19	45·67			A.M.		
							A.M.							

TABLE IV.

JULY Leap Year					AUGUST Leap Year					SEPTEMBER Leap Year				
D.L.	Day	A.M. h	m	s	D.L.	Day	A.M. h	m	s	D.L.	Day	A.M. h	m	s
A	1	5	17	52·48	D	1	3	15	59·29	G	1	1	14	6·09
B	2	5	13	56·57	E	2	3	12	3·38	A	2	1	10	10·18
C	3	5	10	0·66	F	3	3	8	7·47	B	3	1	6	14·28
D	4	5	6	4·75	G	4	3	4	11·56	C	4	1	2	18·37
E	5	5	2	8·84	A	5	3	0	15·65	D	5	0	58	22·46
F	6	4	58	12·93	B	6	2	56	19·74	E	6	0	54	26·55
G	7	4	54	17·02	C	7	2	52	23·83	F	7	0	50	30·64
A	8	4	50	21·11	D	8	2	48	27·92	G	8	0	46	34·73
B	9	4	46	25·20	E	9	2	44	32·01	A	9	0	42	38·82
C	10	4	42	29·29	F	10	2	40	36·10	B	10	0	38	42·91
D	11	4	38	33·39	G	11	2	36	40·19	C	11	0	34	47·00
E	12	4	34	37·48	A	12	2	32	44·28	D	12	0	30	51·09
F	13	4	30	41·57	B	13	2	28	48·37	E	13	0	26	55·18
G	14	4	26	45·66	C	14	2	24	52·46	F	14	0	22	59·27
A	15	4	22	49·75	D	15	2	20	56·55	G	15	0	19	3·36
B	16	4	18	53·84	E	16	2	17	0·65	A	16	0	15	7·45
C	17	4	14	57·93	F	17	2	13	4·74	B	17	0	11	11·54
D	18	4	11	2·02	G	18	2	9	8·83	C	18	0	7	15·63
E	19	4	7	6·11	A	19	2	5	12·92	D	19	0	3	19·72
F	20	4	3	10·20	B	20	2	1	17·01				A.M.	
													P.M.	
G	21	3	59	14·29	C	21	1	57	21·10	D	19	11	59	23·81
A	22	3	55	18·38	D	22	1	53	25·19	E	20	11	55	27·91
B	23	3	51	22·47	E	23	1	49	29·28	F	21	11	51	32·00
C	24	3	47	26·56	F	24	1	45	33·37	G	22	11	47	36·09
D	25	3	43	30·65	G	25	1	41	37·46	A	23	11	43	40·18
E	26	3	39	34·74	A	26	1	37	41·55	B	24	11	39	44·27
F	27	3	35	38·83	B	27	1	33	45·64	C	25	11	35	48·36
G	28	3	31	42·92	C	28	1	29	49·73	D	26	11	31	52·45
A	29	3	27	47·02	D	29	1	25	53·82	E	27	11	27	56·54
B	30	3	23	51·11	E	30	1	21	57·91	F	28	11	24	0·63
C	31	3	19	55·20	F	31	1	18	2·00	G	29	11	20	4·72
			A.M.					A.M.		A	30	11	16	8·81
													P.M.	

TABLE IV.

OCTOBER Leap Year					NOVEMBER Leap Year					DECEMBER Leap Year				
D. L.	Day	P.M. h	m	s	D. L.	Day	P.M. h	m	s	D. L.	Day	P.M. h	m	s
B	1	11	12	12·90	E	1	9	10	19·71	G	1	7	12	22·42
C	2	11	8	16·99	F	2	9	6	23·80	A	2	7	8	26·52
D	3	11	4	21·08	G	3	9	2	27·89	B	3	7	4	30·61
E	4	11	0	25·17	A	4	8	58	31·98	C	4	7	0	34·70
F	5	10	56	29·26	B	5	8	54	36·07	D	5	6	56	38·79
G	6	10	52	33·35	C	6	8	50	40·16	E	6	6	52	42·88
A	7	10	48	37·44	D	7	8	46	44·25	F	7	6	48	46·97
B	8	10	44	41·54	E	8	8	42	48·34	G	8	6	44	51·06
C	9	10	40	45·63	F	9	8	38	52·43	A	9	6	40	55·15
D	10	10	36	49·72	G	10	8	34	56·52	B	10	6	36	59·24
E	11	10	32	53·81	A	11	8	31	0·61	C	11	6	33	3·33
F	12	10	28	57·90	B	12	8	27	4·70	D	12	6	29	7·42
G	13	10	25	1·99	C	13	8	23	8·79	E	13	6	25	11 51
A	14	10	21	6·08	D	14	8	19	12·89	F	14	6	21	15·60
B	15	10	17	10·17	E	15	8	15	16·98	G	15	6	17	19·69
C	16	10	13	14·26	F	16	8	11	21·07	A	16	6	13	23·78
D	17	10	9	18·35	G	17	8	7	25·16	B	17	6	9	27·87
E	18	10	5	22·44	A	18	8	3	29·25	C	18	6	5	31·96
F	19	10	1	26·53	B	19	7	59	33·34	D	19	6	1	36·05
G	20	9	57	30·62	C	20	7	55	37·43	E	20	5	57	40·15
A	21	9	53	34·71	D	21	7	51	41·52	F	21	5	53	44·24
B	22	9	49	38·80	E	22	7	47	45·61	G	22	5	49	48·33
C	23	9	45	42·89	F	23	7	43	49·70	A	23	5	45	52·42
D	24	9	41	46·98	G	24	7	39	53·79	B	24	5	41	56·51
E	25	9	37	51·07	A	25	7	35	57·88	C	25	5	38	0·60
F	26	9	33	55·16	B	26	7	32	1·97	D	26	5	34	4·69
G	27	9	29	59·26	C	27	7	28	6·06	E	27	5	30	8·78
A	28	9	26	3·35	D	28	7	24	10·15	F	28	5	26	12·87
B	29	9	22	7·44	E	29	7	20	14·24	G	29	5	22	16·96
C	30	9	18	11·53	F	30	7	16	18·33	A	30	5	18	21·05
D	31	9	14	15·62				P.M.		B	31	5	14	25·14
			P.M.										P.M.	

Equinox Correction always + E.C. and Lunar Nutation of Equinox L.N.E.

COMMON YEARS				LEAP YEARS				
Year Jan. 1	D. L.	E. C. + m sec	L. N. E. sec	Year Jan. 1	D. L.	E. C. + m sec	L. N. E. Jan. 1 sec	L. N. E. Dec. 32 sec
1869	C	0 57·72	− 0·71	1872	G	3 49·13	− 1·03	− 0·91
1870	B	1 54·85	− 0·93	1876	B	3 41·77	− 0·06	+ 0·28
1871	A	2 51·99	− 1·04	1880	D	3 34·41	+ 1·00	+ 1·05
1872			− 1·03	1884	F	3 27·05	+ 0·51	+ 0·17
1873	E	0 50·36	− 0·91	1888	A	3 19·69	− 0·80	− 0·99
1874	D	1 47·50	− 0·69	1892	C	3 12·33	− 0·84	− 0·58
1875	C	2 44·63	− 0·40	1896	E	3 4·97	+ 0·41	+ 0·70
1876			− 0·06					
1877	G	0 43·00	+ 0·28					
1878	F	1 40·13	+ 0·60					
1879	E	2 37·27	+ 0·85					
1880			+ 1·00					
1881	B	0 35·64	+ 1·05					
1882	A	1 32·77	+ 0·98					
1883	G	2 29·91	+ 0·79					
1884			+ 0·51					
1885	D	0 28·27	+ 0·17					
1886	C	1 25·41	− 0·19					
1887	B	2 22·55	− 0·53					
1888			− 0·80					
1889	F	0 20·91	− 0·99					
1890	E	1 18·05	− 1·05					
1891	D	2 15·19	− 1·00					
1892			− 0·84					
1893	A	0 13·55	− 0·58					
1894	G	1 10·69	− 0·27					
1895	F	2 7·83	+ 0·08					
1896			+ 0·41					
1897	C	0 6·19	+ 0·70					
1898	B	1 3·33	+ 0·92					
1899	A	2 0·47	+ 1·04					
1900	G	2 57·60	+ 1·04					

RULE.

To find, as a substitute for the quantities in Table II. and the Instrumental Correction, 'The Year and Instrumental Correction,' combine from Table V. the Equinox Correction with the Lunar Nutation of the Equinox, add the combination to the Instrumental Correction and diminish the sum by the 10 seconds given to Table III. (to make it always additive), and the sum so diminished will be the Year and Instrumental Correction.

EXAMPLE.

To find the Year and Instrumental Correction for 1869 when the Instrumental Correction is 1 m. 10 sec. +

		m	sec	
From Table V.	E.C. . .	0	57·72	+
	L.N.E. .		71	−
Instrumental Correction . . .		1	10·	+
10 sec. in Table III.			10·	−
Year and Instrumental Correction		1	57·01	+

TABLE VI.

Right Ascension and Amount of Maximum Interstellar Lunar Nutation—M.I.L.N.

Jan 1	RA h m	Diff. m	M.I.L.N. sec	RA h m	Aug. 8
1868	22 52	66	+ 0·48 —	10 52	1886
1869	21 46	80	+ 0·44 —	9 46	1887
1870	20 26	96	+ 0·40 —	8 26	1888
1871	18 50	103	+ 0·37 —	6 50	1889
1872	17 7	95	+ 0·37 —	5 7	1890
1873	15 32	79	+ 0·40 —	3 32	1891
1874	14 13	65	+ 0·44 —	2 13	1892
1875	13 8	58	+ 0·47 —	1 8	1893
1876	12 10	58	+ 0·49 —	0 10	1894
1877	11 12	62	+ 0·48 —	23 12	1895
1878	10 10	74	+ 0·45 —	22 10	1896
1879	8 56	89	+ 0·41 —	20 56	1897
1880	7 27	102	+ 0·38 —	19 27	1898
1881	5 45	100	+ 0·37 —	17 45	1899
1882	4 5	85	+ 0·39 —	16 5	1900
1883	2 40	71	+ 0·43 —	14 40	
1884	1 29	61	+ 0·47 —	13 29	
1885	0 28	59	+ 0·49 —	12 28	
1886	23 29	62	+ 0·49 —	11 29	
1887	22 27		+ 0·47 —	10 27	

TABLE VII.

Multiples of M.I.L.N. corresponding to distance from R.A. of Maximum.

Distance h m	Multiple
1 13	0·95
2 7	0·85
2 46	0·75
3 18	0·65
3 47	0·55
4 13	0·45
4 38	0·35
5 2	0·25
5 25	0·15
5 48	0·05

RULE.

To find the Interstellar Lunar Nutation of a Star on a given date.

From Table VI. take the R.A. of M.I.L.N. and the Amount, with the proper sign, of the Nutation. Multiply the amount by the decimal multiple corresponding, in Table VII. to the difference between the R.A. of the Star and the R.A. of M.I.L.N., and the product will be the Interstellar Lunar Nutation of the Star.

EXAMPLE.

Required the Interstellar Lunar Nutation of 3 Green 66 = μ Andromedæ p. [2] for Aug. 8, 1888.

	h	m	
From Table VI. Aug. 8, 1888, R.A. of M.I.L.N.	20	26	Amount + 0·40
R.A. of Star about	0	50	
Difference . .	4	24	

From Table VII. between 4 13 and 4 38 multiple = 0·4

Interstellar Lunar Nutation of Star = + 0·40 × 0·4 = + 0·16

TABLES I. and II.

Year and Dominical Letter		h	m	sec
1868	Jan. 1	18	33	12·20
E	July 2	18	33	12·09
	Dec. 32	18	33	11·99
1869	Jan. 1	18	30	15·24
C	July 3	18	30	15·15
	Dec. 32	18	30	15·08
1870	Jan. 1	18	31	14·24
B	July 3	18	31	14·18
	Dec. 32	18	31	14·15
1871	Jan. 1	18	32	13·31
A	July 3	18	32	13·29
	Dec. 32	18	32	13·29
1872	Jan. 1	18	33	12·45
G	July 2	18	33	12·47
	Dec. 32	18	33	12·51
1873	Jan. 1	18	30	15·76
E	July 3	18	30	15·82
	Dec. 32	18	30	15·89
1874	Jan. 1	18	31	15·05
D	July 3	18	31	15·13
	Dec. 32	18	31	15·23
1875	Jan. 1	18	32	14·39
C	July 3	18	32	14·49
	Dec. 32	18	32	14·60
1876	Jan. 1	18	33	13·77
B	July 2	18	33	13·88
	Dec. 32	18	33	14·00
1877	Jan. 1	18	30	17·25
G	July 3	18	30	17·36
	Dec. 32	18	30	17·46
1878	Jan. 1	18	31	16·63
F	July 3	18	31	16·72
	Dec. 32	18	31	16·80
1879	Jan. 1	18	32	15·97
E	July 3	18	32	16·04
	Dec. 32	18	32	16·09
1880	Jan. 1	18	33	15·25
D	July 2	18	33	15·29
	Dec. 32	18	33	15·30

TABLE III.

	sec
Jan. 1	8·29
11	8·41
21	8·58
31	8·78
Feb. 10	9·03
20	9·31
Mar. 2	9·63
12	9·94
22	10·28
April 1	10·62
11	10·95
21	11·28
May 1	11·59
11	11·87
21	12·13
31	12·35
June 10	12·53
20	12·67
30	12·76
July 10	12·80
20	12·79
30	12·72
Aug. 9	12·61
19	12·46
29	12·27
Sept. 8	12·04
18	11·80
28	11·54
Oct. 8	11·28
18	11·03
28	10·80
Nov. 7	10·60
17	10·43
27	10·31
Dec. 7	10·23
17	10·22
27	10·26
37	10·35

EXPLANATION

An imaginary point in the heavens, the mean equinox, may be said to revolve round the earth at an uniform rate, passing the meridian at intervals of 23 h. 56 m. 4·090549806 sec. (Shortrede's tables, where the length of an equinoctial day is given in seconds.)

The Fixed Stars also cross the meridian in the order of their "Right Ascensions," which express the time thay pass it after the equinox. This right ascension is not a fixed quantity; each Star according to its position in the heavens is subject to noticeable variations in its right ascension, which may be conveniently arranged in three classes.

1st. With respect to the Stars included in this list there is a continual increase in their right ascensions, amounting to 2 to 4 seconds a year "Precession."

2nd. There is a slight fluctuation extending over a period of 18·6 years, the Star during that time gaining and losing upon its mean place "Lunar Nutation."

3rd. There are two fluctuations apparent during the year, "Aberration and Solar Nutation."

The laws which govern all these movements have been discovered by astronomers, and the movements can be calculated with the greatest certainty, and the positions also of a vast number of Stars have been accurately determined, so that for many years to come the times at which they would pass the meridian on any given day can be predicted to less than a second.

These tables are intended to enable the observer to calculate with very little trouble, and with slight chance of error, the mean solar time of the apparent transits, across the meridian, of the Stars included in the list. It will be sufficient to show that the tables are founded upon and are in accordance with formulæ adopted by the highest authorities.

In the Nautical Almanac, on the page following the "Mean places of the Fixed Stars," it is stated that the apparent right ascension in arc of a Star for the time represented by t is

$$\alpha + A a + B b + C c + D d + t \Delta c$$

where t denotes the time reckoned from the moment when the Sun's mean longitude was 280°, and expressed in fractional parts of a tropical year, and adopting the symbols ☉ for the Sun's, and ☾ for the Moon's true longitude, ☊ for the mean longitude of the Moon's node, ω for the obliquity of the Ecliptic, and α and δ the mean Right Ascension and Declination of the Star for the beginning of the year, we have the following values:

N.A. for 1868

$A = -20''{\cdot}4451 \cos \omega \cos ☉$ and $a = \cos \alpha \sec \delta$

$B = -20''{\cdot}4451 \sin ☉$ and $b = \sin \alpha \sec \delta$

$C = t - {\cdot}02519 \sin 2 ☉ - {\cdot}34241 \sin ☊ + {\cdot}00410 \sin 2 ☊ - {\cdot}00405 \sin 2 ☾$ and $c = 46{\cdot}0816 + 20{\cdot}0549 \sin \alpha \tan \delta$ which call $m + n \sin \alpha \tan \delta$

$D = -{\cdot}5507 \cos 2 ☉ - 9{\cdot}2237 \cos ☊ + {\cdot}0895 \cos 2 ☊ - {\cdot}0885 \cos 2 ☾$ and $d = \cos \alpha \tan \delta$

Δc the annual proper motion in Right Ascension in arc.

In the following tables arc has been reduced to time by dividing by 15. An inspection of the values of *a*, *b*, *c* and *d* will show that they refer to particular points in the heavens; these have been calculated for declination 38 40 = NPD 51 20, and for every 15° of Right Ascension, or every sidereal hour. An inspection of the values of A,B,C,D will show that they are divisible into three classes: 1st. Those which depend upon the Sun's longitude and the time of the year, which may be called A B C′ and D′; 2nd. Those which depend upon the longitude of the Moon's node, which call C″ and D″; 3rd. Those which depend upon the Moon's longitude, and which are very small, and may be altogether neglected (see explanation of article Bessel's Day Numbers in Nautical Almanac), as may also $t \Delta c$, which only applies to individual Stars.

Class 1 have been thus computed; the Nautical Almanac for 1866 was taken as the authority, and the mean of the Sun's apparent longitude on noon Jan. 1 and Jan. 2, after adding the aberration, was adopted as the Sun's longitude for midnight Jan. 1, and the longitude for every other tenth night was found in a similar manner. The value of *t* for midnight Jan. 1, 1866, was taken as ·00385, and the values of *t* for the following tenth nights were found by successive additions to it of ·027379. With the Sun's longitude, and *t* thus obtained the values of ABC′ and D′ were calculated for every tenth night, and by usual methods C′ was combined with *m* and D′ with *d*.

The values of A for every tenth night were marked on the blank side of a slide rule,* and with one fixing of the slide for each value of *a*, the 38 values of A *a* were read off, and in a similar manner the several 38 values B *b* and C′*n* sin α tan δ were obtained.

These five quantities, C′*m*, D′*d*, A *a*, B *b*, and C′*n* sin α tan δ, together with 10 seconds to render the sum always additive, constitute Table III.

The longitude of the Moon's node for midnight Jan. 1, 1866, was calculated from the Nautical Almanac, and taken as 196° 41′·1, and its longitudes for the dates given in Table II. were found by allowing a half-yearly diminution in longitude of 9° 40′·25 (British Association Catalogue, p. 30). From the longitude thus found C″ and D″ were calculated, and C″ combined with *m* in the usual manner, and C″*n* sin α tan δ and D″*d* were taken from the slide rule. In this case with one fixing of the slide, the 26 values of C″*n* sin α tan δ were read off, and similarly those of D″*d*. These three quantities, C″m, C″*n* sin α tan δ, and D″*d*, when diminished by the 10 sec. included in Table III. and increased by the "Equinox Correction," constitute Table II. Thus all the corrections obtainable by the usual methods have been calculated for N.P.D. 51° 20′, and intervals of 15° = 1 sidereal hour, and together with the equinox corrections have been combined in Tables II. and III.

Table IV. has been formed by the repeated addition of 23 56 4·09055, the assumed length of an equinoctial day, to 5 13 28, the time given for Jan. 1. If then the transit of the equinox took place on that day at 5h 13′ 28″ P.M., the table would give the time of its transit on every other day in the year; but it does not pass so soon as that on Jan. 1 in any year mentioned in Table II. The table will consequently require a correction "Equinox Correction" for Jan. 1, and for the remaining days in the same year it will require the same correction.

* Since the slide rule here referred to is on an unusually large scale or "Radius," a description of it is given. The Radius is 33 to 34 inches in length, and is divided 1 (·005) 2 (·01) 5 (·05) 10 and the "modification invented by Mr. Silvanus Bevan," the divided radius was adopted (see English Cyclopædia, art Slide Rule): an examination of the quantities to be calculated by it would show that the calculations could be made with quite sufficient accuracy. Messrs. Dring and Fage, of London, have the brass pattern.

The amount of the correction has been obtained from Le Verrier's tables, one of which gives the Sun's mean longitude at Paris noon for Jan. 1 for every year in this century; and 360° — Sun's mean longitude at noon, when reduced from arc to mean solar time, and diminished by 1·527 sec. to adapt it to the meridian of Greenwich, has been taken as the mean solar time of the transit of the mean equinox, and this time less the 5,,13,,28, given in Table IV. for Jan. 1, constitutes the equinox correction which in each year forms part of the values found in Table II.

The places of the Stars selected for this list have been taken in order of preference from

1. The Greenwich 7-year Catalogue for 1860, designated in column 1 as 3 G, 3 Gr, 3 Gre, &c., according as the Right Ascension depends upon less than 4, 8, 16, &c. observations.
2. The Greenwich 6-year Catalogue for 1850, similarly designated as 2 G, 2 Gr, 2 Gre.
3. The Greenwich 12-year Catalogue for 1840 and 1845, similarly designated 1 G, 1 Gr, 1 Gre.
4. The Radcliffe Catalogue for 1845, R, Ra, Rad, &c.
5. The British Association Catalogue for 1850, B.A.C.
6. Weisse's Bessel for 1825, W.B.

In this list the plan adopted in forming the British Association Catalogue, of combining the places in different catalogues into a mean result, has not been followed; here the Star's place depends entirely upon the catalogue first mentioned in column 1, and the precession, secular variation, and proper motion adopted in that catalogue have been used in bringing up the Star's place to Jan. 1, 1868. In the case, however, of Weisse's Bessel, which does not contain Secular Variations, and the epoch of which is as far back as 1825, the following treatment has been adopted: the Star's place has been brought up 40 years by the formula: precession, or $p_1 = 1842''{\cdot}78 + \log^{-1} 2{\cdot}90436 \sin \alpha_1 \tan \delta_1$; with the Star's place thus brought up, 40 years' precession has been calculated, changing the constants, according to Peters, by the formula $p_2 = 1843''{\cdot}23 + \log^{-1} 2{\cdot}90428 \sin \alpha_2 \tan \delta_2$: the mean of p_1 and $p_2 \div 15$ or $\frac{p_1 + p_2}{30}$ has been taken as the total precession from 1825 to 1865, expressed in sidereal time; $p_2 \div 600$ has been taken as the annual precession 1865, in time, and $p_2 - p_1 \div 240$ has been taken as the Secular Variation. A similar process was applied to the North Polar Distance. From the Star's place thus found for 1865 the place was brought up by the usual methods to 1868.

The sidereal time in which the Right Ascension and Precession of the Stars are expressed in the catalogues was reduced to mean solar time, the former by an extremely convenient Table to be found in Vega's Logarithms, by Dr. Bremiker (Berlin; and Williams and Norgate, London) and the latter by a short manuscript table on the same principle.

It may be noticed that often the Star's number in column 1 is followed by A, BAC, G, R, WB, Σ or ΣΣ. Those letters indicate an agreement to a quarter of a second between the Right Ascensions given in the catalogue from which the Star's place has been taken and the catalogues of Argelander, Epoch 1855, printed 1867; British Association Catalogue, Epoch 1850; Groombridge, 1810; Radcliffe, 1845; Weisse's Bessel, 1825; Struve's Positiones Mediæ, 1830, and in the case of some double stars, a combination of the

same with the Mensuræ Micrometricæ; when WB is followed by L, it indicates an agreement to half a second between Weisse's Bessel and the British Association Lalande, Epoch 1800.

In ascertaining these agreements, it was sufficient in the case of R and G to compare the Groombridge column in the Radcliffe Catalogue with that of the text; Argelander, which has no Precessions, has been compared by the use of the Precessions &c. in the catalogue from which the Star's place has been taken: in the other cases the mean of the Precessions in the two catalogues has been adopted.

A Star's Mean Right Ascension for Jan. 1 in any year up to 1880 will be found by adding to the Right Ascension for 1868 the seconds in column 4, multiplied by the number of years since 1868, and this will be the a in formula apparent Right Ascension $= a + Aa + Bb + Cc + Dd$; and since the corrections $Aa + Bb + Cc + Dd$ for points sufficiently near to the Stars are contained in Tables II. III., which also contain the "equinox correction," working out the rule in page [1] will give the length of time the Star would appear to pass the meridian, after the equinox added to the mean solar time of the transit of the equinox, or in other words the mean solar time of the apparent transit of the Star, which will be true to a second without interpolation.

An approximation to the time of the apparent transit of a Star, less accurate than that given on page [1], but yet possessing some practical advantages, may be obtained by substituting for the quantities taken from Table II. a "year correction," formed by combining from Table V. the equinox correction and the Lunar Nutation of the equinox, and diminishing the amount by the 10 seconds given to Table III., and using this, when combined with the correction for instrumental error, for all Stars alike during the year. One of the advantages of this method is, that instead of having for each observation to combine with the quantities obtained from Tables I. III. and IV. the two quantities, viz. that obtained from Table II., and the correction for instrumental error, there is only one quantity, i.e. the year and instrumental correction which has been combined once for all, and for all Stars at the beginning of each year: thus the addition sum is reduced by one line.

The disadvantage of this plan is, that besides increasing the insignificant error caused by neglecting the change which takes place in the amount of the Lunar Nutation of the equinox during the entire year, another small error is introduced by the omission of the quantity $C''n \sin \alpha \tan \delta + D''d$, which represents the Interstellar Lunar Nutation of the Stars; the amount however of the error is small, not exceeding on any night $\frac{1}{2}$ sec. + or − according to the Right Ascension of the Star observed.

When, however, it is necessary, that error may be very much reduced with ease by means of Tables VI. and VII. Table VI. gives for Jan. 1 from 1868 to 1887, and for Aug. 8 from 1886 to the end of the century. The Right Ascension of the two parts of the zone, which on those days will be subject to the maximum + and − Interstellar Lunar Nutation; together with the amount of the Nutation: The Stars in the other parts of the zone will be affected to a less degree, varying with the cosine of the difference between the Right Ascension of the Star and the Right Ascension of the Maximum. Table VII. will readily give, corresponding to that difference, the decimal multiple for the amount of Maximum Interstellar Lunar Nutation, and the product will be the Interstellar Lunar Nutation of the Star.

Perhaps the most ready way of using these tables would be by writing out on half a

note sheet, 1st. The instrumental correction; 2nd. The combined year and instrumental correction; 3rd. The days of the week and the day letters which in that year correspond to them; thus for 1869

C	Sun.
D	Mon.
E	Tues.
F	Wed.
G	Thurs.
A	Fri.
B	Sat.

and keeping the half note sheet as a book-marker in the right place in Table IV. The day letters will, in a case of uncertainty, fix the day of the month, and the time opposite it should be at once combined with the instrumental correction, or the combined year and instrumental correction, as the case may be; and this day's correction will be good for all Stars for the night.

Certain small errors will arise from the use of these Tables, even when interpolation is resorted to: Taking them in the order of the columns —

1st. The description of time in Table I. columns 3 and 4, is mean solar time, and the hours in the headings, and also the tabular time of Tables II. and III., with the exception of the equinox correction, are all given in sidereal time: the neglect of this difference of time may from both causes produce an error not exceeding 0·08 sec.

2nd. The neglect of secular variation, which ought to count from 1872, since the precessions are those for 1870 rather than for 1868, will for several years to come produce no perceptible error: in the year 1900 the error will not exceed 0·15 sec.

3rd. In Tables II. and III. two sources of error are found: 1st, the corrections there given are too small for Stars of 50° N.P.D., and too large for Stars of 53° N.P.D.; this may introduce an error not exceeding 0·13 sec. in the southern Stars, and 0·11 in the northern; 2nd. The distance between one hour and the next is too great for accurate interpolation, and might in the two tables combined introduce an error not exceeding 0·04 sec.

The sum of the above errors, though insignificant for the ordinary purposes of time-keeping, may be sufficient to condemn the indiscriminate use of the Tables for the purpose of regulating the highest class of mean-time clocks and chronometers. They will, however, be found abundantly accurate for the purpose if the observer will for a considerable period use the same Star, and interpolate for days, if necessary, in Table III. A Star passes the meridian at the end of a month about 2 hours earlier than at the beginning.

It would have been much better if the quantity represented by C′m had been introduced into Table IV. instead of Table III.; the preponderating advantages were, however, discovered too late.

Notes on some of the Stars.

Argelander assigns proper motions, which are not included in the Annual Variations of the following Stars: h 9. R. 2434 P.M. — ·0107 — h 13. R. 3060 P.M. — ·0184 h 14. R. 3265 P.M. — ·0209 h. 14. R. 3269 — ·0198.

h 15. 2 G. 973 After examining Σ. Mens Mic a proper motion of + 0·010 has been included in the Annual Variation.

h 15. 3 G. 1244–5 After comparing 3 G with Σ. Pos. Med. and B.A.C. a P.M. of + 0·013 has been rejected in the Annual Variation.

h 18. 3 G. 1504–5 the P.M. of + 002 has been taken from B.A.C.

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Letter from SIR J. F. W. HERSCHEL, Bart., K.H. &c.

COLLINGWOOD, *July* 7, 1869.

DEAR SIR,

I beg to acknowledge your little book of tables for the reduction of observations of Stars by a small fixed telescope, which, so far as I can perceive, seems a very good way of keeping exact time (say in the country at a distance from any good clock), and very little costly as well as attended with hardly more trouble than would be required for merely uncasing the telescope and looking through it. The only thing which I do not see any advantage in, is the introduction of th

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